REPORT OF THE ROCKY MOUNTAIN RAIL AUTHORITY PEER REVIEW PANEL

PANEL FINDINGS AND RECOMMENDATIONS REGARDING RAIL FEASIBILITY STUDY APPROACH

DECEMBER 2008

Rocky Mountain Rail Authority

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INTRODUCTION

This report captures the substance of the November 2008 meeting of the Rocky Mountain Rail Authority (RMRA) peer review panel. Substantive discussions ranged from topics of clarification to areas of disagreement and expert recommendations for the rail feasibility study (RFS) currently underway. The report is intended to be a summary of the peer review panel's proceedings, with emphasis on recommendations for improving the study's methodology and data use.

PEER REVIEW PANEL OVERVIEW

The Rocky Mountain Rail Authority (RMRA) rail feasibility study (RFS) scope of services calls for convening of a peer review panel. The purpose of the peer review panel is "to increase study credibility, develop new ideas not hindered by existing institutional constraints, improve customer (RMRA) value through value engineering and other similar processes, and suggest ways to develop programs that increase collaboration and seamless flows between the affected agencies; (e.g., local government, RTD, RFTA, PPRTA, CDOT and the Federal agencies). They will be open to the public, interested Board members and others." (RFS Scope of Services)

The peer review panel is tasked with examining the following technical areas:

- Travel demand, revenue, and model integration
- Alternatives development and evaluation
- Overall system design, cost, finance, and implementation

It is anticipated that the panel will meet twice, once early in the process to review methods being used by the RFS study consultant and once late in the process to review and assess the project findings. The November 19 and 20, 2008 meetings were the first of the two peer review panel meetings.

The peer review panel is intended to be conducted in the context of the overall objectives of the RFS, that is, to complete a fresh, objective assessment of the feasibility of implementing high speed rail service in the Colorado corridors and to identify the next steps that should be pursued by RMRA and partner agencies in the implementation of that service. The RFS goals outline that the study should build on previous efforts, coordinate closely with other ongoing relevant studies, survey stakeholders within the two corridors, and identify the most effective high-speed rail options for each corridor.

The peer review panel was asked to consider FRA's six high speed rail feasibility factors when conducting its review of the RFS. FRA's six high speed rail feasibility factors are as follows:

1. Whether the proposed corridors include rail lines where railroad speeds of 90 miles or more per hour are occurring or can reasonably be expected to occur in the future.

2. The projected ridership associated with the proposed corridors.

3. The percentage of the corridors over which trains will be able to operate at maximum cruise speed, taking into account such factors as topography and other traffic on the line.

4. The projected benefits to non-riders, such as congestion relief on other modes of transportation servicing the corridors.

5. The amount of federal, state and local financial support that can reasonably be anticipated for the improvement of the line and related facilities.

6. The cooperation of right-of-way owners that can be reasonably expected in the operation of the high-speed rail passenger service in the corridors.

Building on those six objectives, the study approach is also designed to address two critical financial performance measures:

- System operating ratio (operating revenue / operating cost)
- Cost benefit ratio

PANEL COMPOSITION AND SESSION ATTENDANCE

The composition of the RMRA peer review panel is diverse and includes experts from various disciplines and sectors. Expertise on the panel includes backgrounds in high speed rail technology, freight rail, travel demand forecasting, project finance, program implementation, environmental assessment, and planning. Peer review panel members were selected to represent perspectives of both public agencies and private consulting as well as their areas of technical expertise. Sessions were open to the public, but primarily attended by RMRA members and CDOT representatives. Attendees are documented in Exhibit 1.

SESSION 1 AGENDA

The agenda for the first panel session was intended to allow focused discussion of the study consultant's methodology, and to make recommendations to RMRA's Feasibility Study Steering Committee (FSSC) regarding methodology enhancements. Technical focuses included the overall business plan approach; ridership and revenue forecasting; technology alternatives and operating costs; operating plans/costs; and corridor development and capital cost estimating. Peer review panel sessions were moderated by Mark Boggs (PBS&J) the RMRA Project Management Consultant. Each session began with a methodology presentation by the study consultant, Transportation Economics and Managements Systems (TEMS). The peer review panel then engaged the study consultant in a question and answer session, and subsequently deliberated in closed session regarding final conclusions and recommendations. Exhibit 2 summarizes the proceedings of the two day peer review panel session agenda.

Exhibit 1
Peer Review Panel Attendees
Session 1 (November 19 to 20)

Peer Review Panel

David Averill – *Regional Multi-Modal Planner, North Front Range Metropolitan Planning Organization (RMRA FSSC member)*

Dick Bauman – *(Private consultant, retired)*

Mark Boggs (Panel Moderator) – *Project Director, PBS&J (RMRA Project Management Consultant)*

Raymond Ellis – *Managing Director, DMJM Harris*

David Foster – *NC Dept of Transportation, Rail Environmental Programs Manager*

David Kurth – *Cambridge Systematics, Inc.*

Bob Leilich – *Trainmaster, Inc.*

Bill Moore – *MPO Administrator, Pueblo Area Council of Governments, MPO/TPR, City of Pueblo (RMRA FSSC member)*

David Muñoz, Ph.D. – *Associate Professor, Colorado School of Mines*

Erik Sabina – *Regional Modeling Manager, Denver Regional Council of Governments*

RMRA Board Members and Other Guests

Tim Baker – *CDOT*
Harry Dale – *RMRA Chairman*
Shawn Han – *JFSA / I-70 PEIS*
Steve Hoover – *PBS&J*
Sandi Kohrs – *CDOT*
Peter Kozinski – *CDOT*
Tammy Lang – *CDOT*
Tom Mauser – *CDOT*
Gene Putman – *City of Thornton*
Flo Raitano – *I-70 Coalition*
Juan Robles – *CDOT*
George Scheuernstuhl – *DRCOG*
Tim Tetherow – *JFSA / I-70 PEIS*

Consultant Team

Edwin “Chip” Kraft – *TEMS*
Alex Metcalf – *TEMS*
Charlie Quandel – *Quandel Consulting*

Exhibit 2
Peer Review Panel Agenda

Day 1: November 19, 2008

- Panel-only breakfast – introductions/organization/overview
- Welcome and Introductions – Harry Dale, RMRA Chairman
- Orientation: operating rules, study goals, corridor orientation
- Study approach: Business Plan Process
- Ridership and revenue forecasting
- Ridership and revenue forecasting, discussion
- Technology alternatives, operating plans & costs, and evaluation
- Day 1 Wrap-up: panel directions to study consultant

Day 2: November 20, 2008

- Follow-up to Day 1 discussions: questions by panel of TEMS team
- Corridor development, capital cost estimation, and evaluation
- Financing, Funding, and Implementation (Removed from agenda due to time constraints)
- Panel deliberations (panel only) – conclusions and writing assignments

METHODOLOGY REVIEW

The peer review panel reviewed and discussed four technical topics including: (1) the overall study approach; (2) ridership and revenue forecasting; (3) technology alternatives and operating cost estimates; and (4) corridor development and capital cost estimation.

1. GENERAL STUDY APPROACH: BUSINESS PLAN PROCESS

The peer review panel evaluated the study consultant's business plan process for conducting the RFS. The study consultant summary of the business plan process is included in Appendix A. In general, the study consultant's business plan follows a six step process, which is represented in Exhibit 3:

- Public outreach and database development – Assembling the engineering, market, operational, technology, and community station data as input to the process.
- Formulation of rail service scenarios – Setting up the rail/maglev options to be considered for the study.
- Interactive analysis – Assessing engineering, market, operational, technology, and land use data to identify and develop the most effective rail/maglev alternatives.
- System forecasts and outputs – For the most effective alternatives, generating ridership, revenue, operating costs, capital costs, and financial and economic feasibility solutions. This includes user and community benefits, as well as FRA criteria.
- Assessment of institutional and financial plan options – Developing the institutional framework, and funding plan for developing the Rocky Mountain Rail System.
- Implementation and business plan – Developing both implementation and business plans along with pro forma financial cash flows.

On the whole, the peer review panel concurs with the study consultant's overall approach. Based on its discussion with the study consultant and further deliberations, the peer review panel offers the following specific observations and recommendations regarding the overall business plan approach.

- The panel recognizes that RMRA and the study consultant have a significant challenge in addressing financial and economic feasibility of high-speed rail service in two very different corridors, and in the case of the I-70 corridor, one that is likely unique in the US. Much of the discussion with the study consultant and recommendations regarding the study approach are made in an effort to improve on the analysis and findings for these different, unique corridors, in a study being conducted with a recognized absence of data. In this regard, the panel is reasonably comfortable with reliance on the study consultant's mid-west experience for modeling the I-25 corridor, and allowing additional time to address the unique characteristics of the I-70 mountain corridor.
- Meeting FRA user and non-user benefit requirements may be only a portion of what is considered feasible. There are political factors and public image issues that may have to be reconciled when determining feasibility. The study approach is highly

analytical, and as noted above, is based on what the panel considers to be a sound approach, but the panel is concerned that the approach may be overlooking significant political, environmental, and public perception challenges. While the panel recognizes that it is beyond the scope of the study to conduct even a high-level environmental assessment, the panel also urges that any study findings and recommendations be tempered by consideration of potential non-financial fatal flaws.

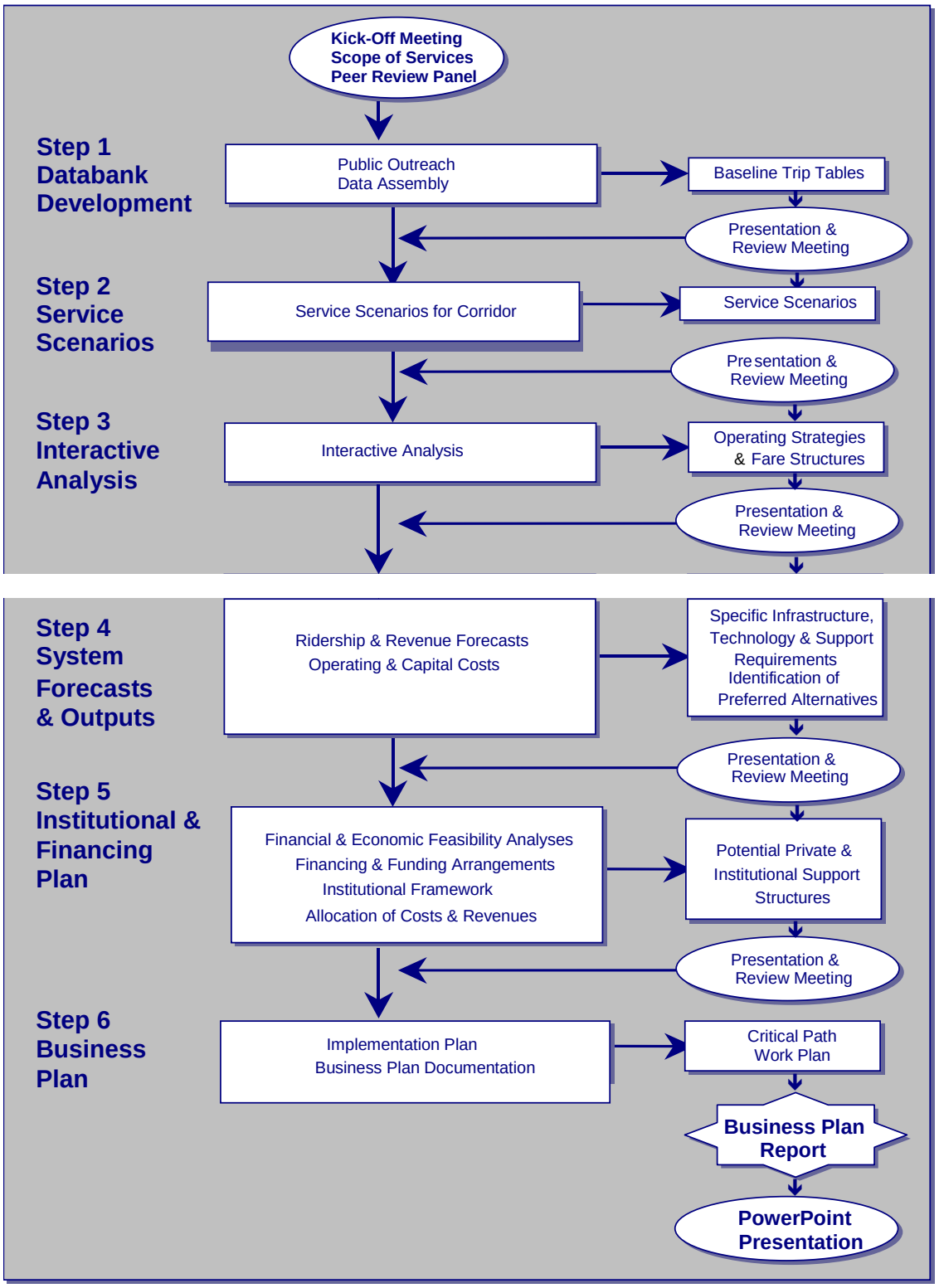
- While the panel recognizes that the primary objective of the study is to assess the feasibility of high-speed rail service and the potential for receiving federal high-speed rail financial assistance, the RMRA should be monitoring developing federal legislation, which may be trending toward funding of intercity passenger rail service for less than HSR applications.

- The business plan's conclusions are frequently referred to as investment grade results. However, the models inputs will be too general for its conclusions to be considered as such. The panel is concerned that continued use of this term will give the impression to decision-makers that the results of the analysis have more reliability than is warranted. The study consultant has clarified that their process is considered investment grade, but as is the nature of feasibility studies, the results themselves will not be detailed enough to meet that standard.

- The business plan process should consider the cost-offsetting benefits and revenue potential of using HSR or HSR infrastructure for non-passenger transport purposes. For example, significant markets may exist to transport freight during low demand passenger travel periods. Currently, Union Pacific turns away traffic through the mountain corridor because it is over capacity. HSR could potentially meet the additional capacity required by Union Pacific and perhaps serve to alleviate demand for truck freight in the mountain corridor. While it may be beyond the scope of the RFS to estimate such revenue, a subjective assessment of potential may bolster the case for financial feasibility when making application for federal funding and should be addressed in the study's final feasibility discussions.

- Revenue forecasts and feasibility potential could be similarly enhanced by considering the potential for partnerships with electric utilities as HSR through the mountains could present a potential opportunity to expand electrical transmission capacity. Panel member David Muñoz provided contacts with relevant utility representatives in the I-70 mountain corridor. Contact information is included in Appendix B.

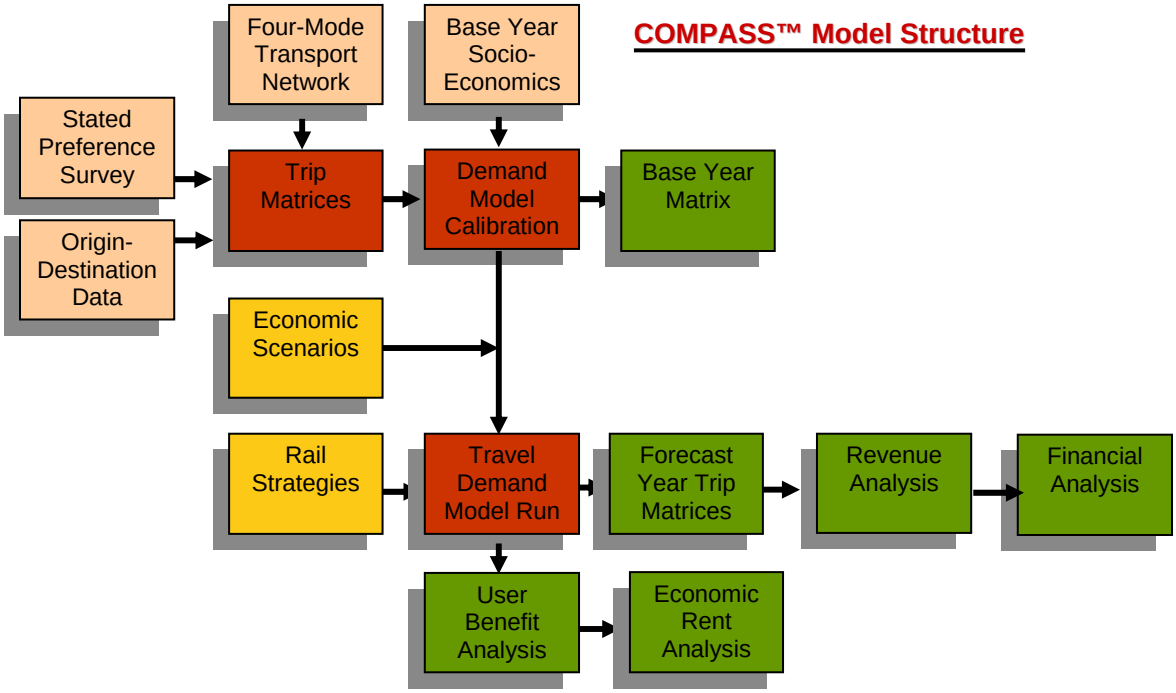
Exhibit 3
Six-Step Business Plan Approach



2. RIDERSHIP AND REVENUE FORECASTING

The peer review panel examined the study consultant model used to predict ridership; the study consultant's presentation is included in Appendix C. As described by the study consultant, the travel demand model will forecast the impact of trip making increases and the role of the rail mode. The study consultant will use the COMPASS model system (see Exhibit 4) which combines existing regional transportation planning techniques with new market research techniques.

Exhibit 4
Ridership and Revenue Forecast Process



Based on the study consultant's presentation, clarification responsive to panel questions, and the panel's further deliberations, the peer review panel offers the following observations and recommendations regarding the ridership forecasting approach.

- With regard to the identification and application of **trip purposes and market segmentation**:
    - Travel market segmentation needs to be reexamined. The panel suggests expanding the market segmentation for intercity travel in the I-70 corridor to provide better differentiation among various trip purposes, and subsets of purposes, especially for recreational trips (winter tourist versus recreational travel and summer tourist versus recreational travel). In particular, the panel is

concerned that the model in the I-70 corridor may not be reflecting the difference between winter travel patterns, when trips are focused on a limited number of ski destinations, and summer patterns, which may be heavier than winter and also apparently has heavier overall volumes than winter.

- The panel suggests segmenting the I-70 mountain corridor market analysis by peak and off-peak travel, to reflect the severe congestion that occurs during normal peak periods and during recurring breakdowns due to weather or traffic incidents. However, for this study, the panel observes that at minimum, day of week is probably more indicative of the peak and off-peak travel markets than time of day of travel.

- Other seemingly unique relationships within the corridors were identified during discussion with the study consultant, such as the large number of employment-driven trips to and from ski areas during the week, and the mountain residents who commute to Denver. Characteristics of seasonal recreational and employment travel vary greatly and need to be captured. Considerable work apparently has been completed in this arena through the I-70 PEIS. The study consultant should use this PEIS travel market information or explain why the data are not applicable.

- With regard to the distribution of trips and the structure and development of the inter-zonal **trip table**:

  - The panel recommends that the base year trip tables for the I-25 south corridor markets be based on the external surveys conducted by the Denver and Colorado Springs MPOs. The panel was not able to identify another intercity travel which would provide a reasonable basis for survey expansion.

  - The panel suggests that trip tables be estimated based on travel surveys and market analysis studies conducted for the I-25 North EIS, the I-70 PEIS, and the 1997 Denver Regional TBI for external stations.

  - The panel recognizes the critical nature of the final trip tables to credible study results, and is interested in reviewing the study consultant's final trip tables as soon as possible.

- With regard to development of mode choice parameters and the use and application of **Stated Preference Surveys**, the panel agrees with the value of conducting the SPS, but has concern over its application. More specifically:

  - The panel is concerned that a detailed SPS survey design has not been developed or, at least, provided for review. The SPS implemented to date appears to be overly simplistic with a survey design that may not reflect the unique travel markets being studied. For example, surveys collected at the Colorado Department of Motor Vehicles do not seem to provide a sample representative of long distance travelers capable of trading marginal travel cost and travel time savings for long distance travel. Airport-based surveys may suffer from the same issues unless respondents who were not traveling from DIA to either of the study corridors have been screened from the database.

- The study consultant has an excellent opportunity to address some of the panel's concerns in its conduct of the winter SPS. Eagle County Airport, Aspen Airport, ski shuttle/van services, ski resort parking lots, Winter Park Ski Train are all seen as excellent opportunities to enhance survey results. The winter survey must recognize the varying markets of the ski areas closest to Denver (e.g., Loveland, Arapahoe Basin, Keystone, and Breckenridge) compared to those further to the west (e.g., Copper Mountain, Vail, Aspen or Steamboat Springs).

- The study consultant should consider using I-70 PEIS data and meet with JF Sato to investigate the applicability of the I-70 revealed preference surveys (RPS) as well as the I-70 PEIS SPS. The panel believes the I-70 PEIS RPS and SPS should be used in the RFS unless there is a compelling reason to do otherwise.

- The study consultant may want to consider including income stratification in their market analysis.

- There is some concern that all explanatory power of the model is tied to value of time (coefficient of travel time and coefficient of travel cost) and all other variation is explained by modal constants. Other factors such as baggage/ski check-in may be important but seems to be excluded from the analysis.

- Greater explanation of induced demand is required. Is there internal consistency between induced demand generated from the introduction of HSR and changes in mode choice forecast? And will induced demand vary by technology type? For example, if induced demand resulting from the introduction of HSR increases trips for an interchange by 10%, are 80% to100% of the induced trips forecast to use HSR for the interchange, or do 20% of the induced trips use HSR and 80% use automobiles?

- The panel needs to know if air travel is considered an alternative mode to HSR (along with bus and auto).

- With regard to **travel forecasts years and forecasting of model inputs,** and forecasting consistency and credibility:

  - To enhance study credibility, socioeconomic data originating from the State Demography Office must be used in the model as the RFS is largely state funded and is intended to build upon other studies using the same data. This data is necessary for having a common baseline with other studies such as the I-70 PEIS and I-25 DEIS. The study consultant should (1) confirm that the data it received from the MPOs were derived from the Colorado State Demography Office and (2) use this data in its model.

  - The study consultant should consider having traffic and revenue forecasts prepared for two forecast years at a minimum. Two important forecast years are (1) opening year after a ramp-up period and (2) 20 to 25 years after the new intercity system is in revenue service. Study consultant forecasts assume that projects documented in fiscally constrained transportation improvement plans are implemented. The panel recommended that the study consultant discuss other likely future projects with CDOT given the 2040 horizon year of the RFS.

  - The study consultants have specified relationships between in-vehicle and out-of-vehicle travel time in the generalized cost equations. However, what relationships will be used and how were they originally established is unclear. The peer review panel would like further discussion of this in the next session.

- With regard **to model validation and documentation:**

  - Data integrity and compatibility with other studies requires that the RFS use data from the I-70 PEIS and I-25 DEIS. This data is widely considered credible and would therefore benefit the RFS model. This data would also offer greater detail in some areas (such as breakdown of recreational trips) and may fill in some of study consultant's data gaps. The study consultant team was given discretion in their use of the data, however, if the I-70 PEIS / I-25 DEIS data is not used, the team must thoroughly document their reasons for its exclusion. It was also strongly suggested that the study consultant team meet with Shawn Han of JF Sato and Associates regarding the I-70 PEIS and the CH2M Hill, I-25 DEIS consultant team.

  - The study consultant should demonstrate consistency of the results of its SPS with the results of the RPS and SPS conducted for the I-70 PEIS study. This same recommendation can be made for all elements of the travel model development. Results should be compared to PEIS and other forecasts as validation. If the study consultant finds reason to question those previous studies, then the rationale for this decision must be clearly documented.

  - The panel is concerned about the study consultant's comments regarding the use of observed traffic counts for model calibration and validation. If the study consultant intends to build base trip tables and then use origin-destination matrix estimation (ODME) techniques to adjust the base tables, this procedure must be specified including how they plan to build the representative seed trip table and how they plan to stratify the resulting ODME trip table by market segment (business, commute, or other) or, alternatively, stratify the observed traffic counts by those market segments. Simply achieving statistical match of traffic counts is neither necessary nor sufficient in demonstrating the validity of the models. It is also necessary to show that the match was achieved using generally acceptable travel forecasting methods and that the model is reasonably sensitive to input assumptions.

  - The peer review panel asks that the model validation and sensitivity testing be clearly documented. The existing model validation plan in the Draft Methodology Technical Report (Section A.3 – Model Validation) is unclear regarding specific validation and sensitivity tests as well as the source of observed data for the tests.

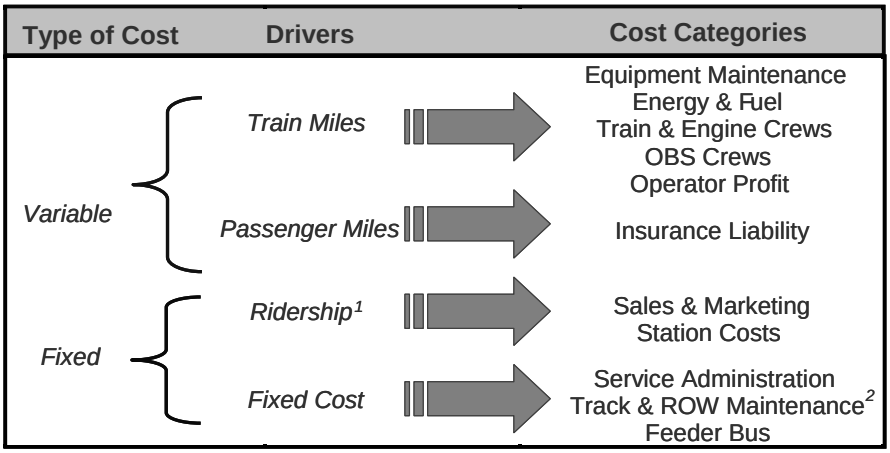
In general, the panel fully understands that challenges of both a data-poor forecasting environment and the unique travel characteristics of the I-70 corridor. Given this setting, the panel thinks it is very important to the credibility of the RFS results that the study consultant thoroughly document its model development process so its results can be compared to and build upon previous work done in the corridor (particularly the I-70 PEIS and I-25 North studies).

3. TECHNOLOGY OPTIONS AND OPERATING COST ESTIMATION

The study consultant reviewed the technology considered for the RFS and the methodology for evaluating these options. The complete presentation is available in Appendix D. The presentation emphasized that the technology options used in the study are representative, and characterize numerous options within each class of train. For example, the choice of Talgo for the 130-mph diesel option provides a cost-effective train that offers a reasonable degree of tilt and a set of good performance characteristics. However, many other manufacturers are also capable of providing an equal (or even faster) train that could also meet those performance specifications. The technology screening process also seeks to focus evaluation on technologies that are either currently commercially available, or have a reasonable chance of being available within an anticipated 15-20 year implementation period. This has resulted in the screening of many technologies that are still early in their product development process.

The study consultant also presented the assumptions used for estimating operating cost. The presentation is included in Appendix E. In general, operating costs will include variable and fixed costs illustrated in Exhibit 5. The study consultant also presented their cost model, using costs and worksheets created during previous projects. These handouts are contained in Appendix E.

Exhibit 5
Operating Cost Categories



[1] Station costs as well as sales and marketing are only affected weakly by ridership, so these two costs can be considered fixed for practical purposes.

[2] For improved track, maintenance costs are affected more by freight tonnage than by passenger train-miles.

Based on its discussion with the study consultant and further deliberations, the peer review panel offers the following observations and recommendations regarding the approach to identifying technology options and estimating operating cost.

- The panel generally agrees with the study consultant's approach to screening of technology options, and with the stratification of technologies for purposes of broad evaluation of feasible alternatives. However, the panel does offer the following comments and recommendations:

- The panel has little confidence in the ability of current vendors to provide a Transrapid type of maglev, and believes that such technology could be removed from the study with little loss of credibility. There is less confidence in the maglev cost estimates than those of other technologies. The study consultant could shift its resources from studying maglev in the I-70 mountain corridor to an evaluation of EMU technology within the existing I-70 mountain corridor (maximizing the use of existing CDOT right of way).

  Should the study team continue to investigate either the HSST or Transrapid maglev technology, then study reporting should make it clear that continued investigation of maglev carries the following risks associated with the following factors:

  - To date, neither Transrapid nor HSST have been willing to enter into contracts for delivering and operating maglev services in accordance with the customary commercial terms and conditions for other urban transportation systems. The Transrapid Consortium in Germany was not able to offer a firm fixed price contract for the construction and operation of the Munich airport access prototype. and the buyer cancelled the maglev procurement. Siemens has discontinued its operation of the Transrapid test track until such time as a maglev market is identified. HSST is unable to offer a firm fixed price contract for the construction and development of its urban scale maglev technology. HSST is willing to enter into contracts in which the risks and the costs of implementing Maglev technology are shared with the client – but this is not a normal and customary commercial arrangement.

  - Maglev has never been operationally tested and deployed in as harsh winter environment like the Rocky Mountain I-70 Corridor, whereas the more traditional steel wheel technologies under consideration have been so-deployed.

- The study consultant is encouraged to consider the ability to accommodate different technology on a common track (i.e., accommodate freight during off-peak hours).

- The panel also accepts the general methodology for estimating operating costs of the various alternatives, with the following comments and recommendations:

  - Operating cost estimates must be tailored to reflect the unique and rugged characteristics of the I-70 corridor. Costs for snow and rock removal are likely to be considerable. Similarly, a cost provision should be made for snow sheds in avalanche prone areas. Heating rails could be a potentially high cost. The panel suggests examining these costs closely and contacting Union Pacific for their winter related maintenance costs.

  - The panel discussed speeds set for alignments using existing freight rail. The majority of panelists believed that 90 mph should be used as it is the ceiling held by FRA. However, others believed that maximum speeds of 110 mph should be used.

  - Amtrak operation and maintenance costs should be the benchmark for the RFS.

- All costs need to be of the same year.

- The study consultant requested that a risk factor be provided by the panel. The peer review panel would prefer that the study consultant propose suitable risk factors, for further panel review.

- Tom Stone's "DesertXpress" (www.desertxpress.com) could offer some useful information for EMU technology traversing challenging terrain.

4. CORRIDOR DEVELOPMENT AND CAPITAL COST ESTIMATION

Routes proposed for the I-70 and I-25 corridors were examined by the peer review panel. For comparative purposes, multiple routes were proposed for each corridor. Alignment options include, existing Interstate highway and rail right of way, broader highway corridors, and greenfield alignments. The corridor alignments discussed by the peer review panel are illustrated in Appendix F.

Based on its discussion with the study consultant and further deliberations, the peer review panel agrees that it is appropriate that the study consultant assess the varying alignment options noted above, as each has both positive attributes and negative features that will allow a better overall feasibility assessment. While the panel offered suggestions on specific alignment modifications and potential stations, these aspects are not part of the panels charge, and will be conveyed to the FSSC separately. Further observations and recommendations regarding the identification and evaluation of alternative alignments and estimation of capital costs are as follow:

- The panel suggested that grade crossings where speeds exceed 90 mph should be avoided. If this is infeasible, the decision of where to include grade separations should be a function of crossing activity. The Colorado Public Utilities Commission, which regulates rail crossings in the state, has published standards for grade separations. The study consultant work should conform to the state standards.

- The panel has strong concern about routing alignments through National Forest land. The hurdles of implementing such an alignment were said to be significant – to the level of being considered an infeasibility. While the panel recognizes the value in examining alignments that allow grades and curves to be minimized, the study must nevertheless recognize in its feasibility discussions if there are political hurdles to using a particular area (i.e., National Forest land).

- Many on the panel believed that using an operating grade of 4% as a maximum threshold is perhaps too low and would eliminate potentially attractive routes. Their recommendation is to use a 7% grade instead. Opponents argued that increasing the threshold would eliminate opportunities to accommodate freight operations.

- The 96th Avenue route to DIA is problematic from a NEPA and right of way standpoint. The route would require either taking new homes or encroaching on wildlife land.

- With regard to the study's capital cost estimating approach, the panel generally agrees with the approach and with the unit costs being used, but advises consideration of the following aspects.
    - The study consultant's per mile costs do not factor the numerous stream crossings that will be required in the I-25 corridor.
    - Utility relocation is likely to be a significant cost depending on the alignment. A line item cost should be established for utility relocation.
    - In light of the very high cost of tunneling and the potential for long tunnels in the I-70 corridor, the implication of newer tunnel boring technology needs to be addressed. Technology capable of producing 3 lane bores should be examined. The panel recommends contacting Trailer Brothers and ACS Dragados.

OTHER COMMENTS AND GENERAL CONCLUSIONS

Peer review panel discussions focused on the issues that seem most likely to either enhance the results of RMRA's study, or could cast doubt on the study results. Specific topics and recommendations for the four principal elements of the study approach have been documented above. Peer review panel discussions also focused on big-picture topics and issues not specifically recognized in the agenda or project scope. These discussion points are summarized below.

- The overall process and methodology is fine. The peer review panel understands that the study consultant is operating in a data poor environment and is undertaking an ambitious task in a relatively short timeframe and with a finite budget. The challenges facing the study consultant are well recognized by the peer review panel.
- Due to the level of detailed questions regarding the COMPAS model, modeling experts on the peer review panel are interested in meeting again with the study consultant before their modeling is completed. The panel requires more information regarding the model coefficients, calibration procedures, and model validation results and sensitivities.
- Early communication and cooperation with BNSF and UP was identified as a key component of success for Colorado HSR efforts. Gene Skoropowski, Director of the Capital Corridors in California was identified as a good resource for successful cooperation with BNSF and UP.

In closing, the Peer Review Panel wishes to thank RMRA for providing the opportunity to participate in an exciting and potentially significant study. The panel also wishes to acknowledge the forthright presentations and discussion offered by the study consultant, and the consultant's apparent interest in hearing the panel's recommendations for further strengthening the study approach and results. The panel is anxious to continue its review of the study consultant's work, and is willing to support the process in any additional ways seen fit by the RMRA board and steering committee.

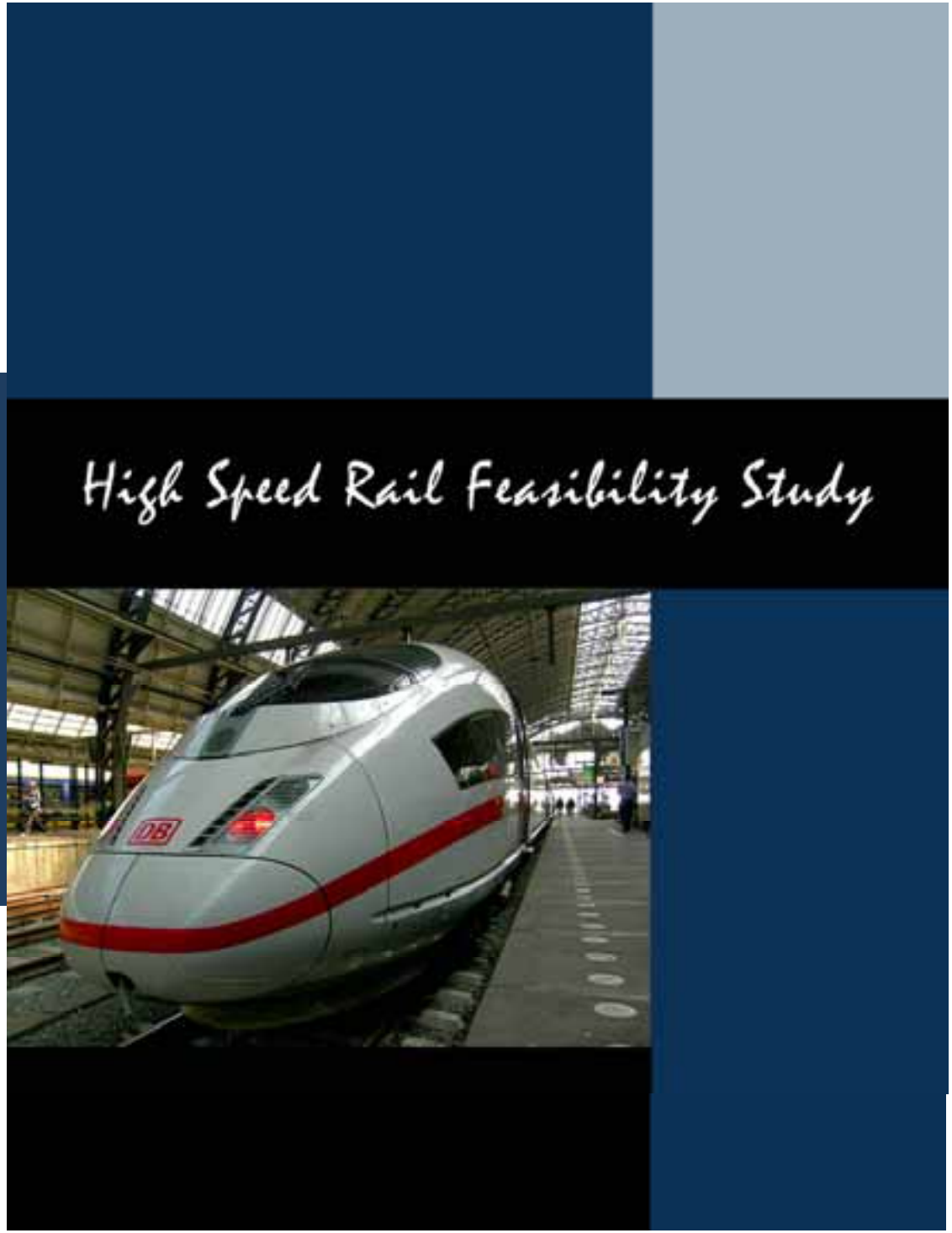
APPENDIX A: BUSINESS PLAN PROCESS PRESENTATION

Presentation To

RMRA Peer Panel Workshop – Day #1

Business Plan Process

November 19, 2008



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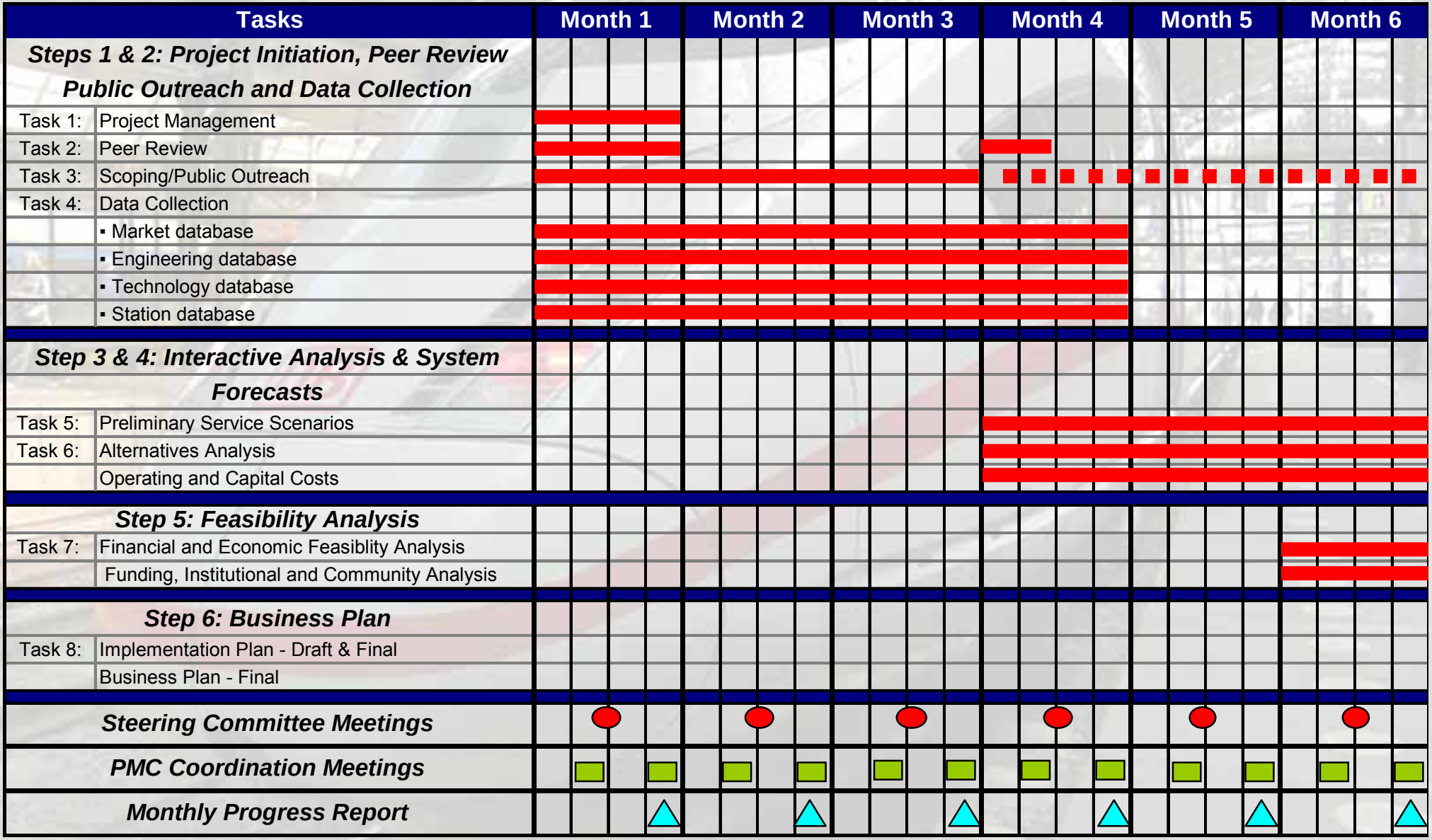
Study Time Scales – Months 1 thru 6



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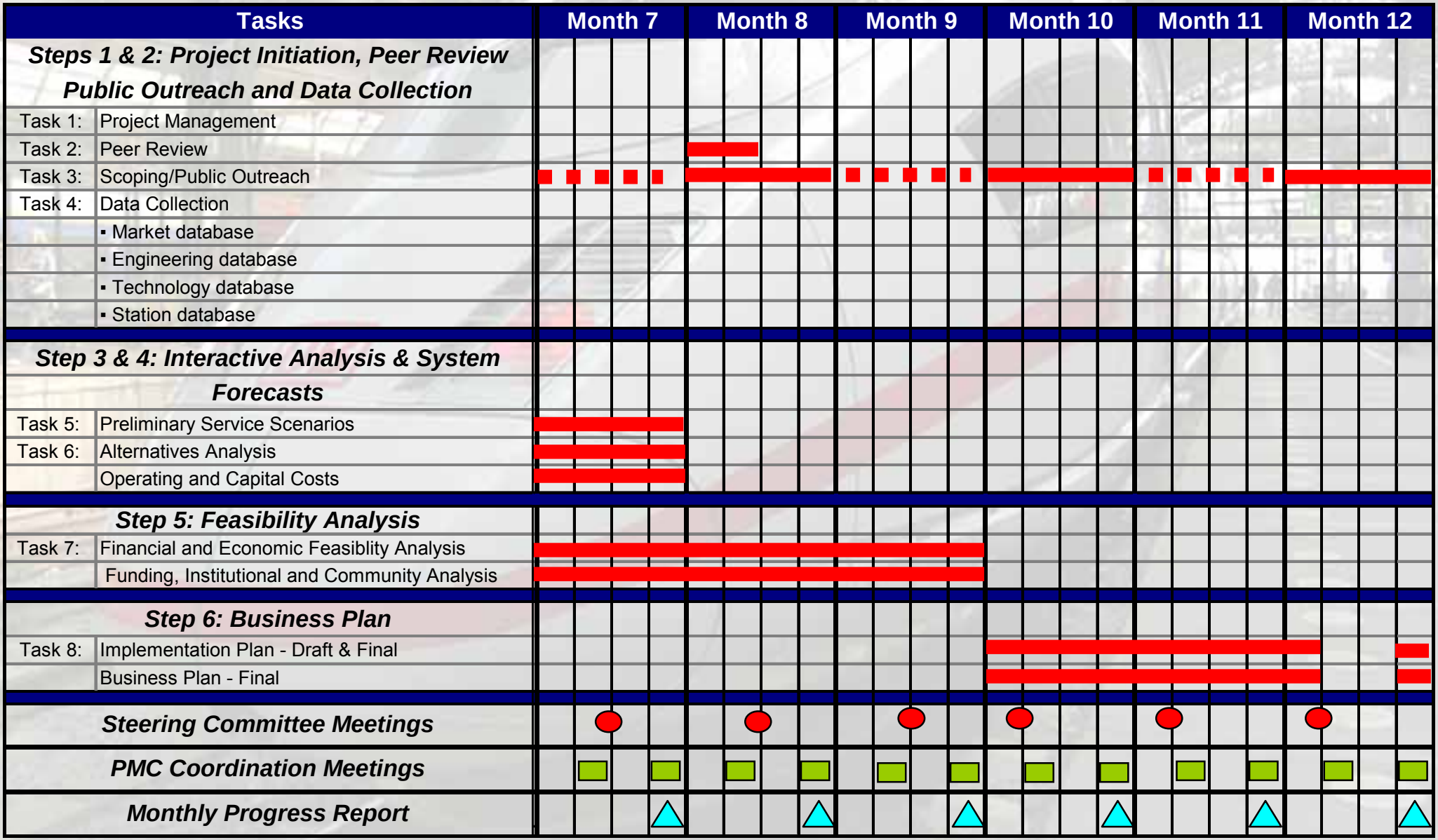
Study Time Scales – Months 7 thru 12



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Study Objectives that will be met

FRA Public/Private Partnership Potential –

- **POSITIVE OPERATING RATIO**
- **POSITIVE COST BENEFIT RATIO**

This requires an assessment of six criteria –

- Identification of proposed corridors that have existing rail lines where railroad speeds of 90 miles or more per hour currently occur or can be expected to occur in the future.
- Projected ridership associated with the proposed corridors.
- Percentage of the corridors over which trains will be able to operate at maximum cruise speed, taking into account factors such as topography and other traffic on the line.
- Projected benefits to non-riders, such as congestion relief on other modes of transportation servicing the corridors.
- Amount of federal, State and local financial support that can reasonably be anticipated for the improvement of the line and related facilities.
- Cooperation from right-of-way (ROW) owners that can be expected in the operation of the high-speed rail passenger service in the proposed corridors

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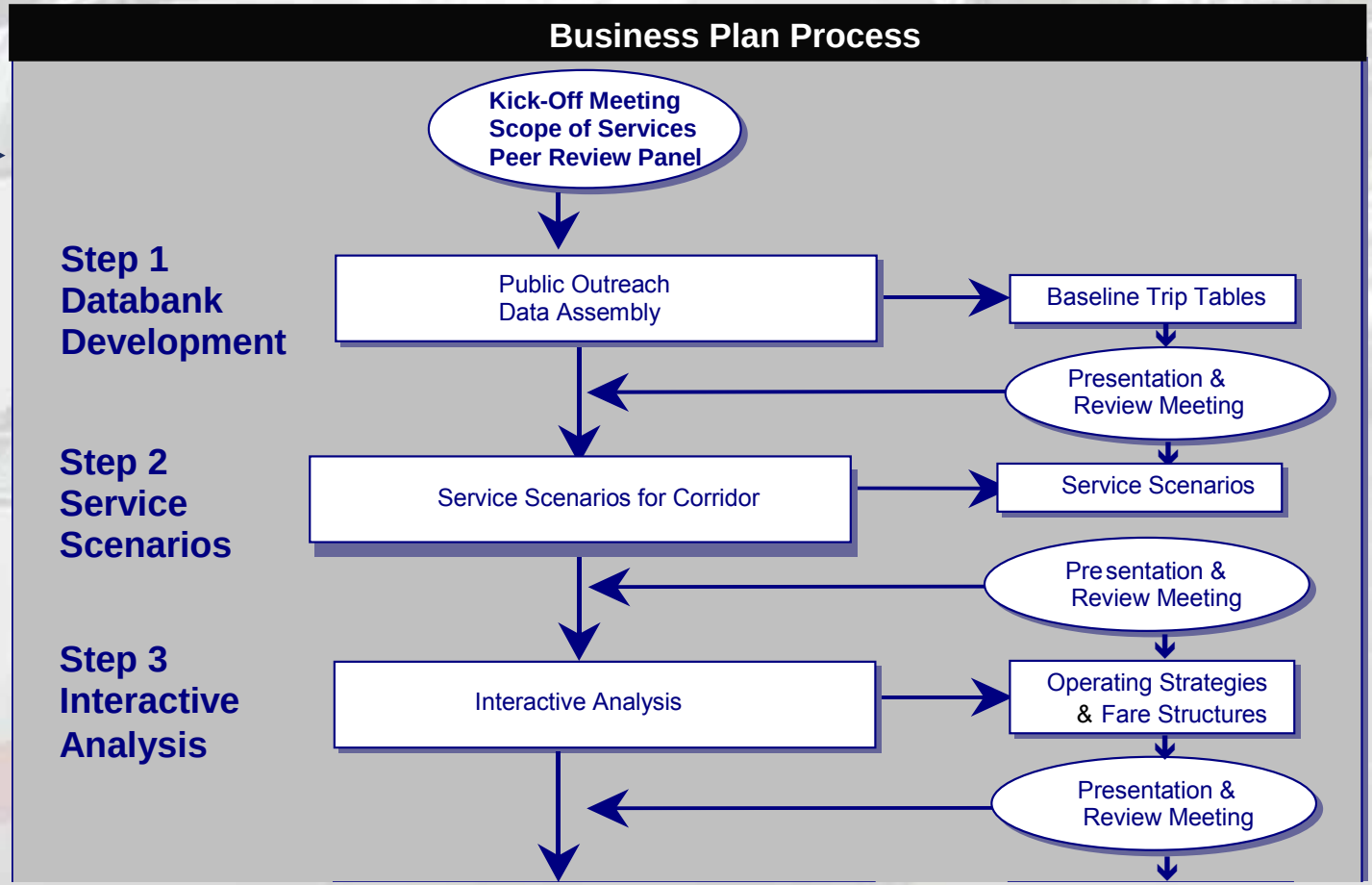
The RMRA Feasibility Study will be completed using the….

Business Plan Six Step Process

- Stated Preference Survey
- Investment Grade Ridership Forecasts
- Computerized Track Database
- Community Economic Development
- Implementation and Business Plan
- Pro forma Financials



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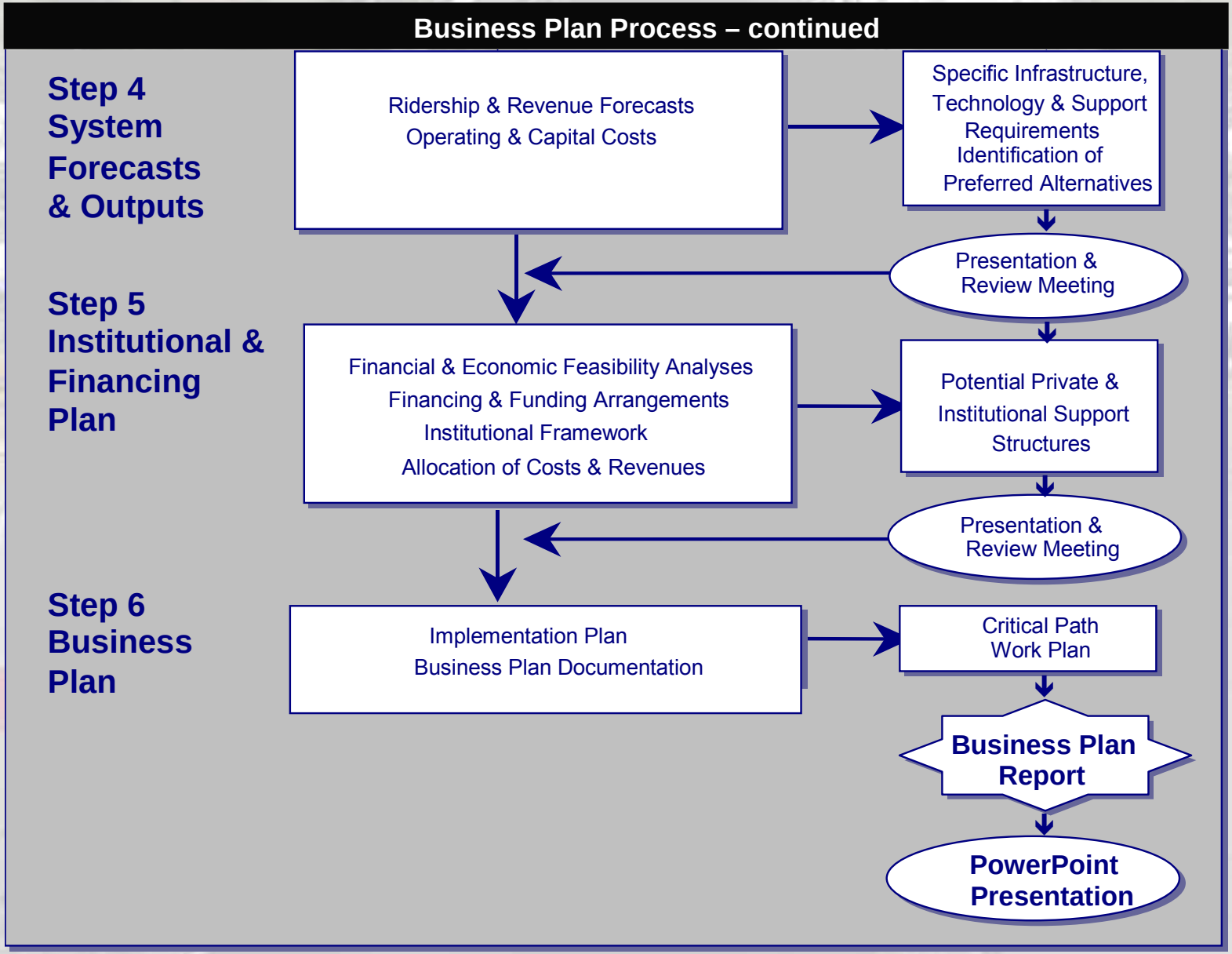
Business Plan Process – Part 2


Business Plan Process – continued
Step 4 System Forecasts & Outputs
Ridership & Revenue Forecasts
Operating & Capital Costs
Specific Infrastructure, Technology & Support Requirements
Identification of Preferred Alternatives
Presentation & Review Meeting
Step 5 Institutional & Financing Plan
Financial & Economic Feasibility Analyses
Financing & Funding Arrangements
Institutional Framework
Allocation of Costs & Revenues
Potential Private & Institutional Support Structures
Presentation & Review Meeting
Step 6 Business Plan
Implementation Plan
Business Plan Documentation
Critical Path Work Plan
Business Plan Report
PowerPoint Presentation

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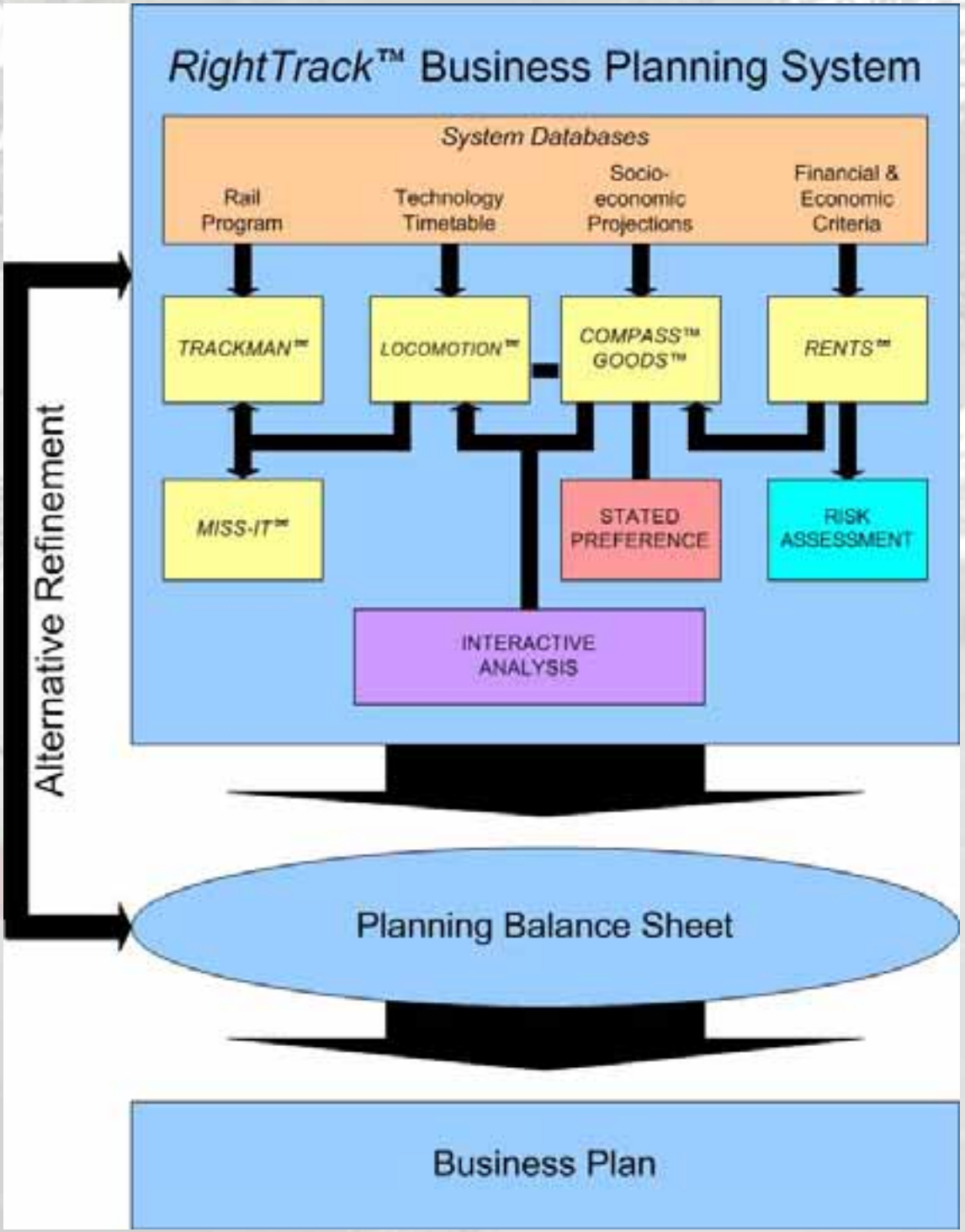
The work will be efficiently completed using the…….

RightTrack™ Business Planning System



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Task 1: Deliverables

The TEMS Team will conduct the following management activities and coordinate with the RMRA:

1. **Project Management Plan Preparation – A Project Management Plan will be prepared within 10 days of the Notice to Proceed.**
2. **Steering Committee Coordination – The TEMS Team will meet monthly with the RMRA Steering Committee.**
3. **Coordination with the Project Management Consultant (PMC) – The TEMS Team will meet/conference call bi-weekly with the PMC.**
4. **Coordination with other study teams (I-70 coalition, CDOT freight relocation, etc.).**
5. **Preparation of meeting notes for all official project meetings (excluding RMRA Board or Steering Committee meetings).**
6. **Monthly progress reports and invoices.**

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Task 2: Peer Review Panel Support

- PMC to set up Peer Review Panels.
- Three (3) Peer Review Panels, two (2) meetings each. Peer Review Process designed to increase creativity and provide guidance on methodology:
  - Meeting 1 to inform, review and discuss
  - Meeting 2 to advise and provide feedback.
- The Peer Review Panels will examine the following technical areas:
  - Travel demand, revenue, and model integration – *A. Metcalf*
  - Alternatives development and evaluation – *C. Kraft*
  - Overall system design, cost, finance and implementation – *C. Quandel.*

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Task 2: Deliverables

For this task, the TEMS Team will prepare for Steering Committee and PMC review the following:

- **Six PowerPoint presentations**
- **Meeting notes for all official project meetings (excluding RMRA Board and Steering Committee meetings)**
- **TEMS Team review and response to comments by the Peer Review Panels**

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Task 3: Scoping / Outreach

Business Plan Step 1: Database Development

- **Scoping Goal:** Obtain input/support for study goals, Purpose & Need and evaluation criteria
- Three Scoping Workshops
  - I-70 Coalition County Based Input Team
  - I-25 County Based Input Team
  - Denver Metro Area Sub-Team
- Media Relations
- Community Partnership Program Outreach

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Task 3: Scoping / Outreach

- Monthly web/email updates
- Opportunistic materials development and outreach (e.g. community benefits)
- Technical and Policy Outreach:
  - Six County Based Input Team Workshops
  - Media Conference Calls
  - Plug-and-Play content to Community Partnership Team
  - Five Community Information presentations

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Task 3: Deliverables

For this task, the TEMS Team will prepare for Steering Committee and PMC review the following:

- **Stakeholder Outreach Approach technical memorandum**
- **Scoping technical report**

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Task 4: Methodology, Data Collection and Summary of Existing Conditions

Business Plan Step 1: Database Development

- Review Existing and prior reports/studies
- Develop four critical databases
  - Market
  - Engineering
  - Operations
  - Station/property

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Task 4.1: Market Database

The market database will consist of four components:

- **Origin / Destination Data** – Traffic movements by mode and purpose (business, commuter, special interest, tourist)
- **Socioeconomic Data** – Population, Employment and Income by zone.
- **Network Data** – Comprehensive modal networks will be developed for each mode of intercity travel (auto, rail and bus).
- **Stated Preference Data** – The survey will be similar to recent high speed rail surveys completed by TEMS in the Midwest (9 states), Ohio (5 states) Gulf (5 states) and Mid Atlantic (4 states).

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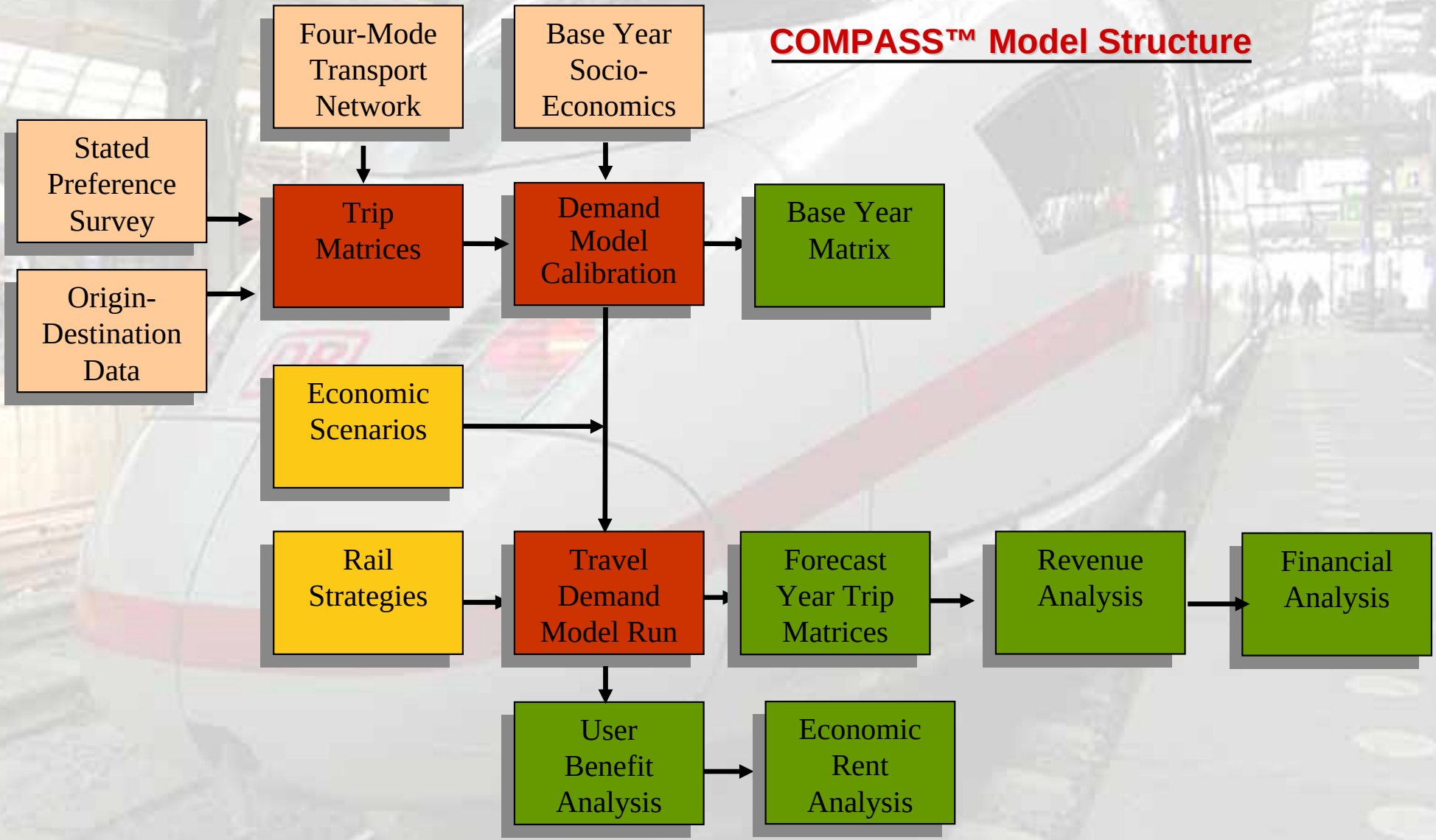
We will use Investment Grade Methodology



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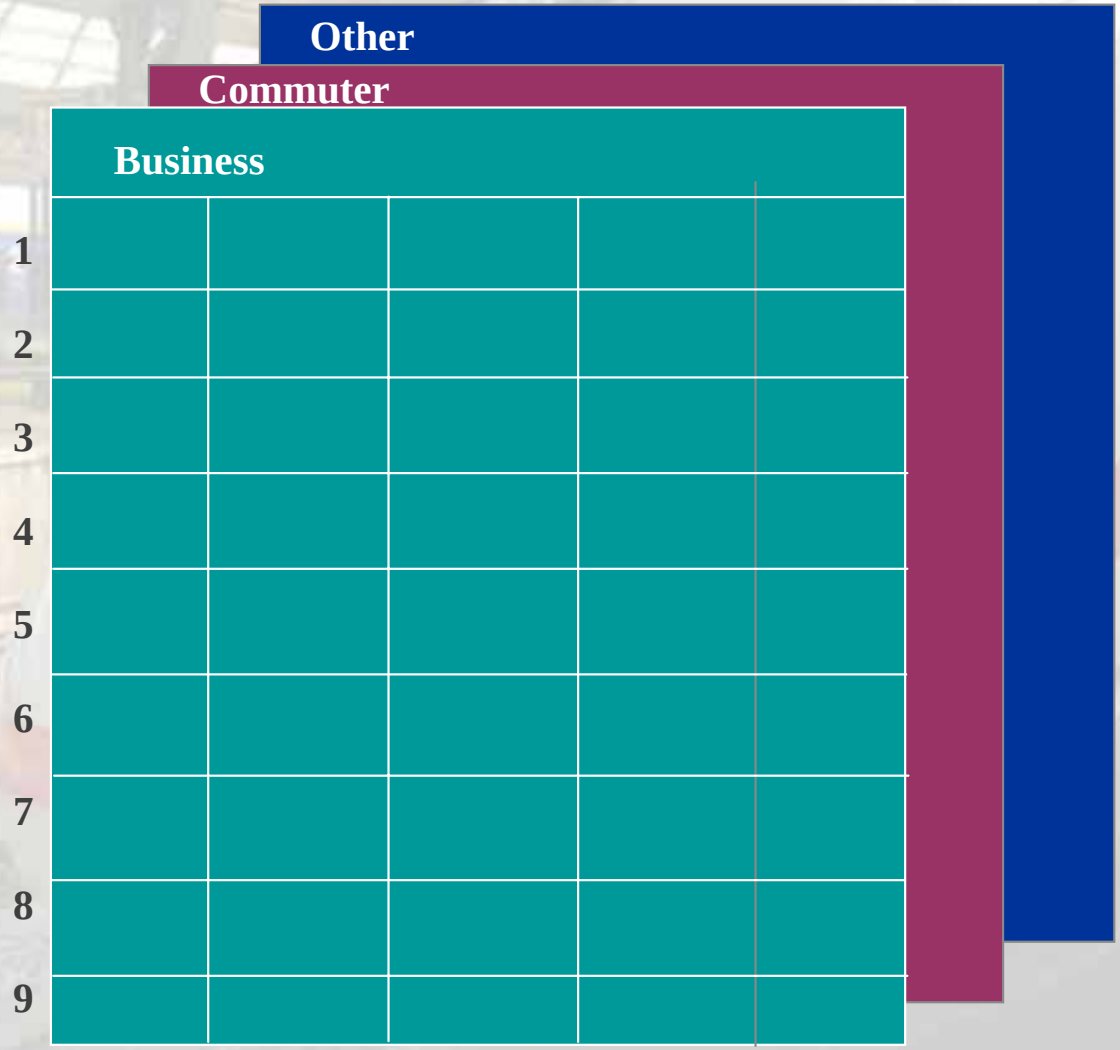
We will build a Sound and Comprehensive Database



"Using MPO and Stated Preference Data to create a sound behavioral database for passenger rail planning"

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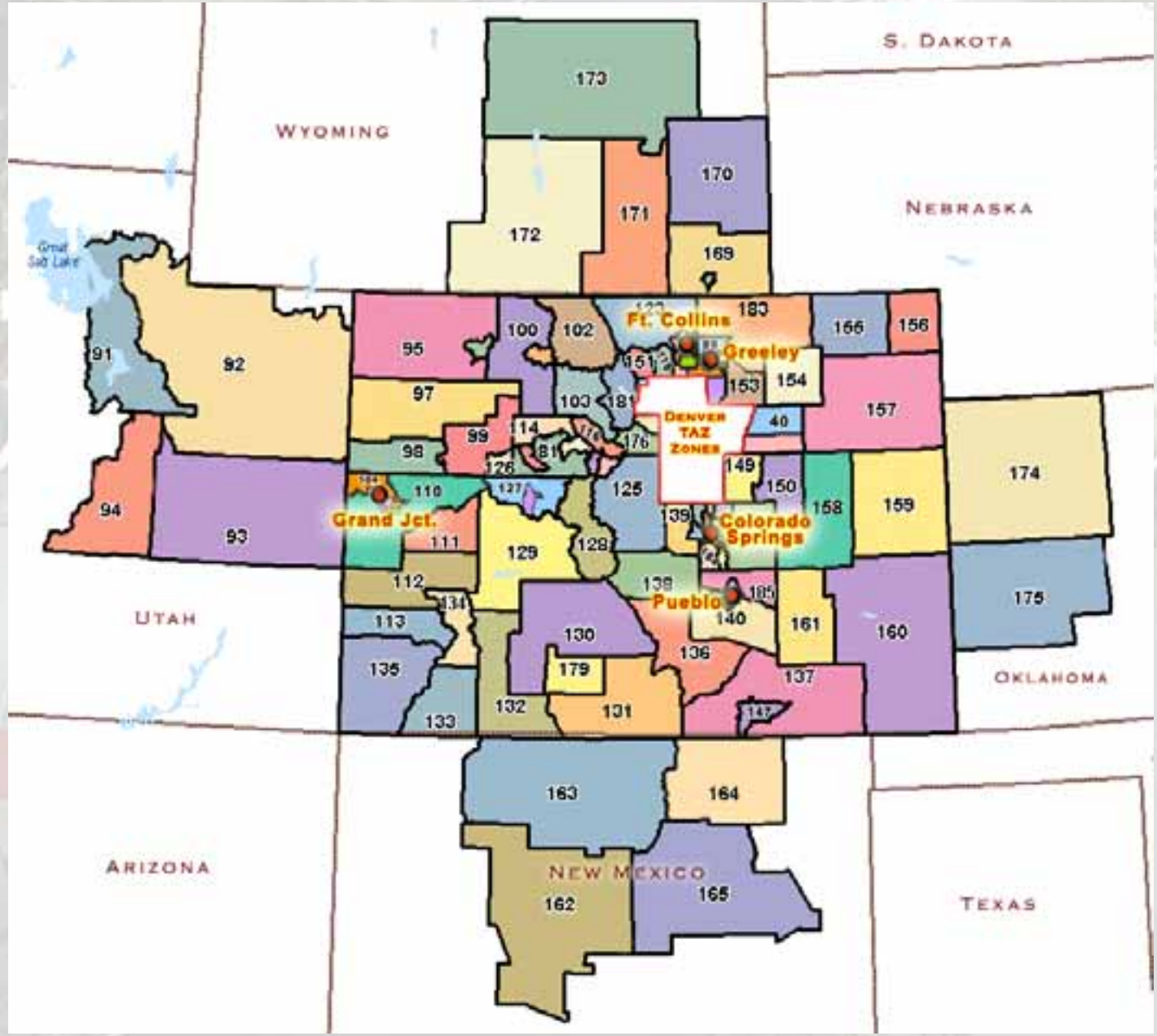
Zone Map



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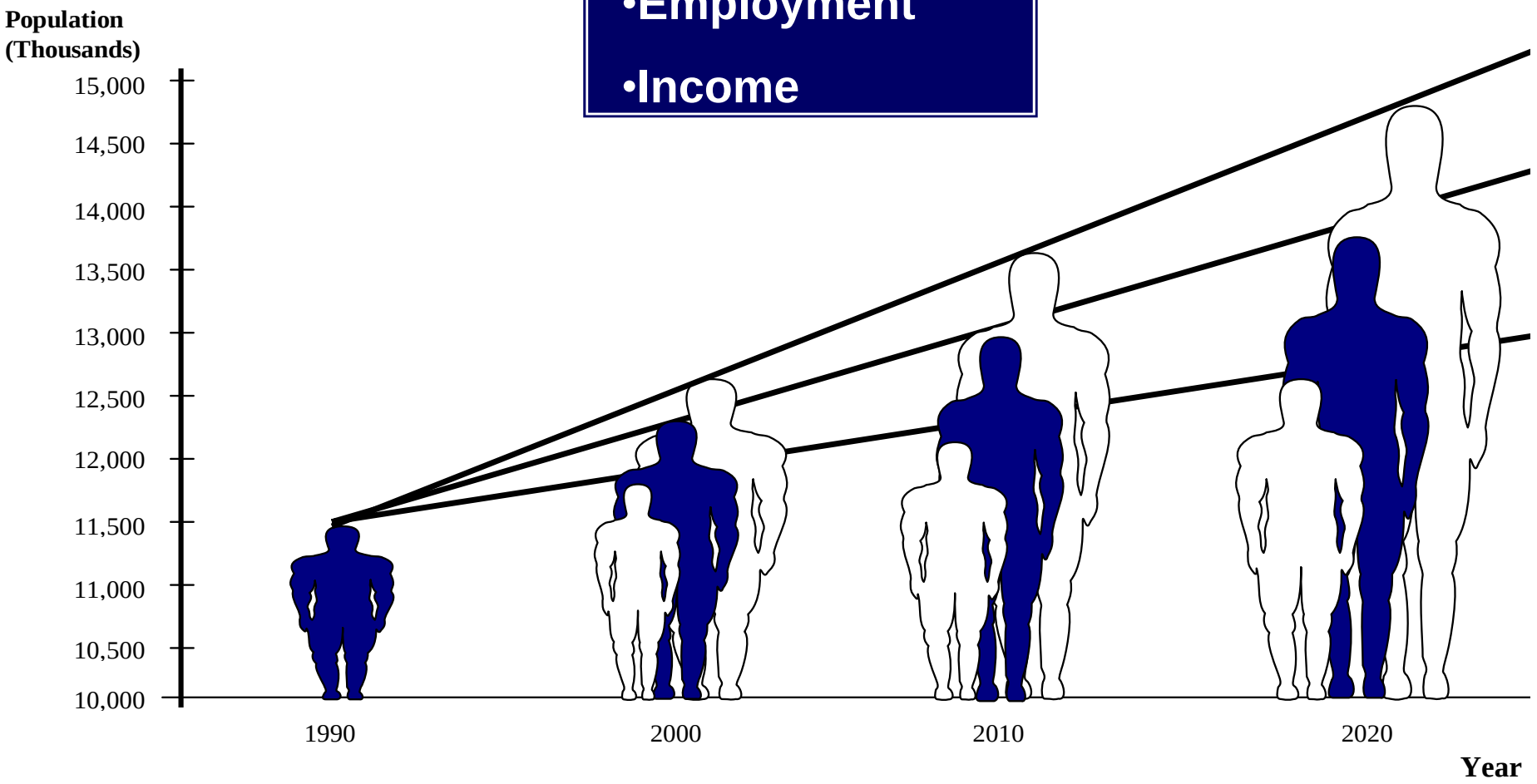
Socioeconomic Projections

- Population
- Employment
- Income



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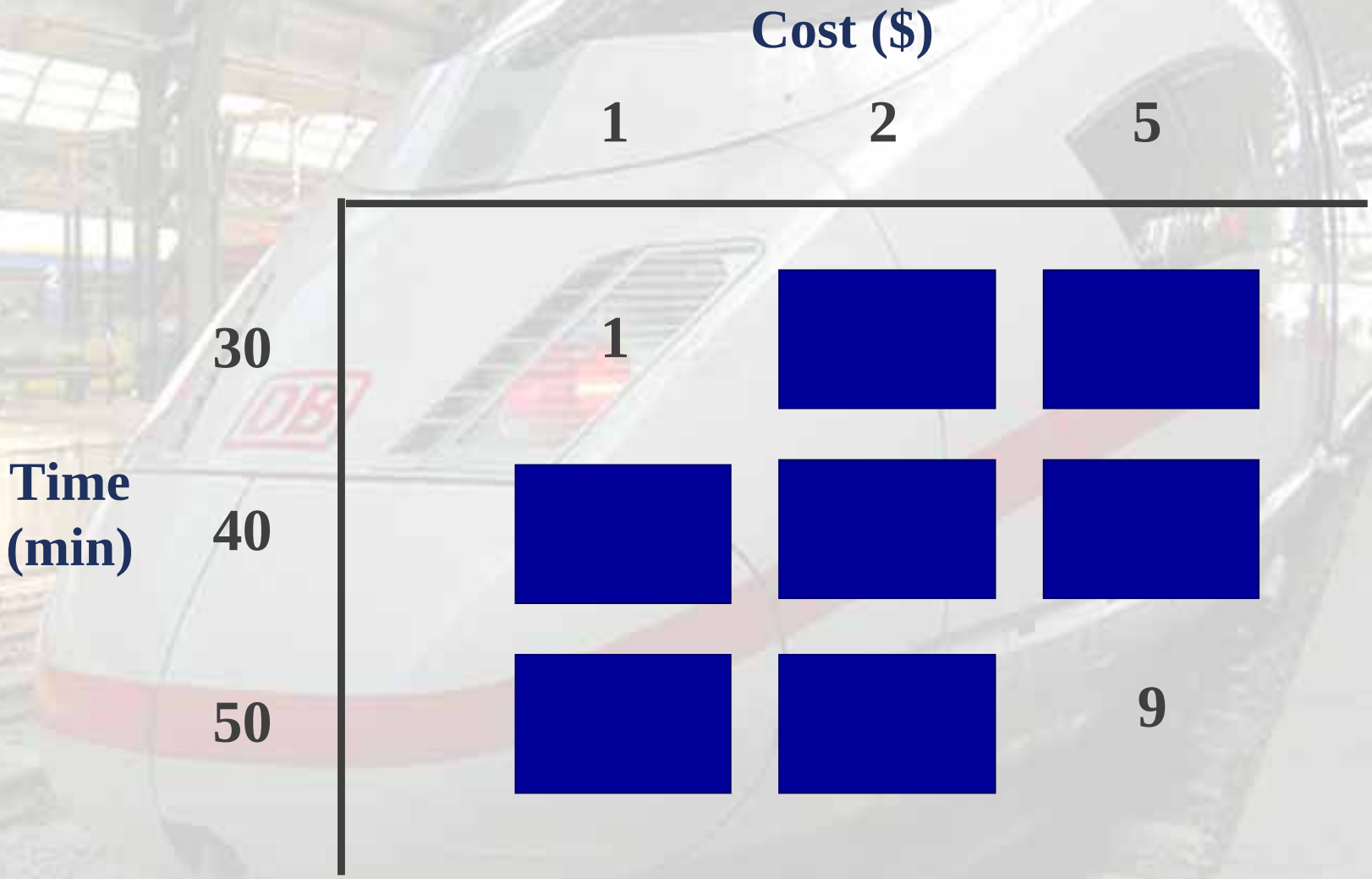
We will carry out a Stated Preference Survey



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Task 4.2: Engineering Database

The engineering database will consider both the east-west corridors and north-south corridors together with potential secondary corridors.

- **The TRACKMAN™ program will provide a milepost-by-milepost record of rail gradients and geometry of the right-of-way.**
- **Data will be compiled from existing sources including:**
  - **Railroad timetables**
  - **Track charts**
  - **USGS topographic maps**
  - **Commercially available orthophotography and**
  - **As-built plans for the I-70 and secondary highways.**
- **The database will provide a basis for estimating potential route alignments**

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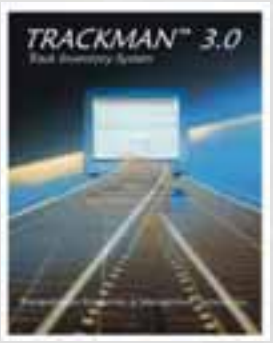
TRACKMAN™ will estimate the Engineering Capital Costs for each RMRA alternative

- Field Survey to Verify Conditions and Update TRACKMAN™ Track Chart Data
- Adjust Unit Costs to Local Engineering Conditions
- Develop Specific Infrastructure Proposals and Cost Estimates for each set of track or right of way Speed Improvements and Line Capacity Upgrades



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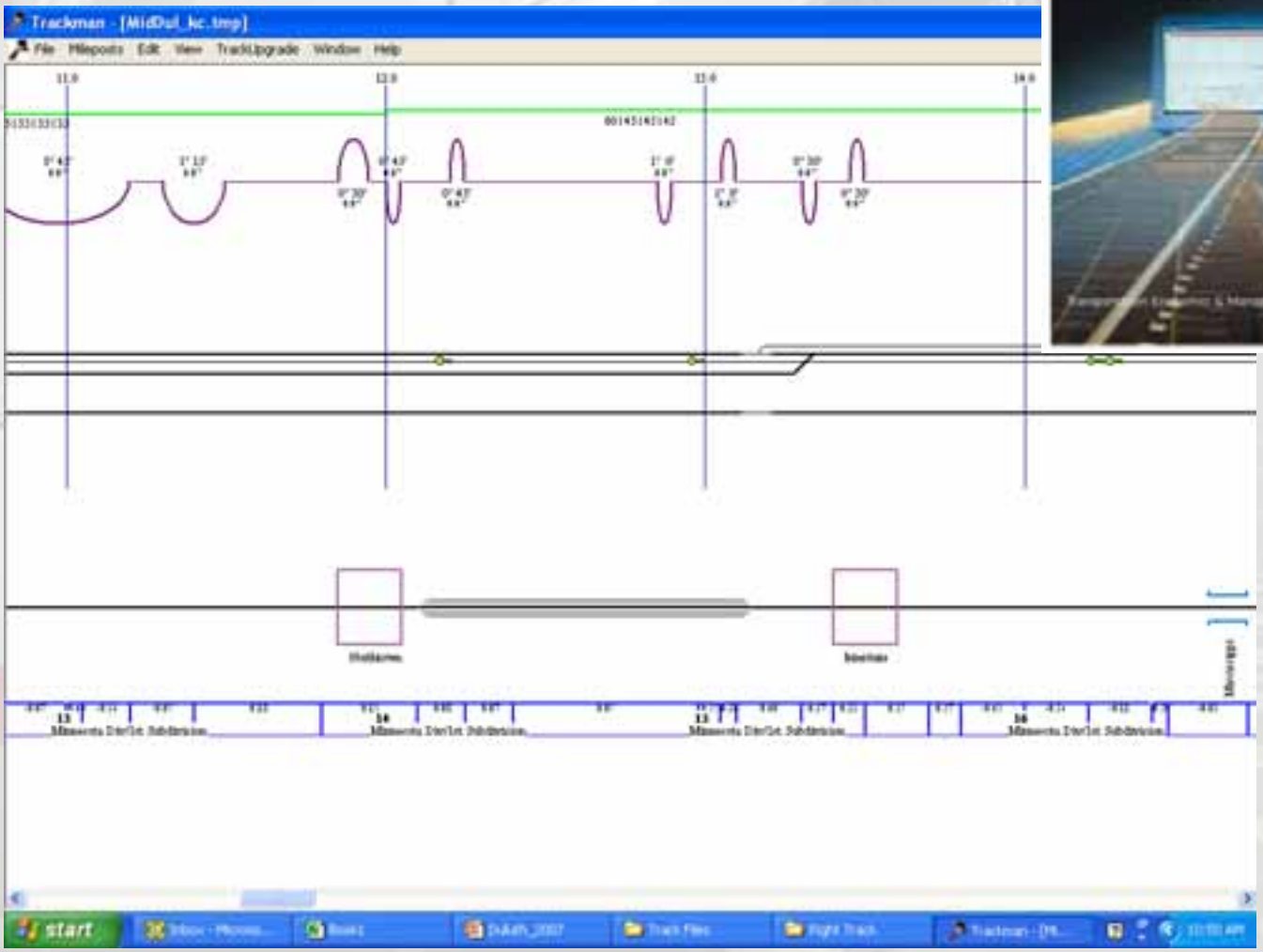
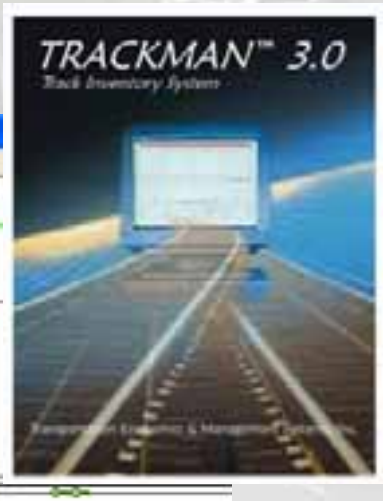
In TRACKMAN™ we will develop detailed information on each route

Key inputs: Speeds, curves, grades, rail and highway crossings, and other potential speed restrictions such as moveable bridges

All the data is being captured in a consistent computerized format, to facilitate train performance and future line capacity evaluation

Sample Duluth Data





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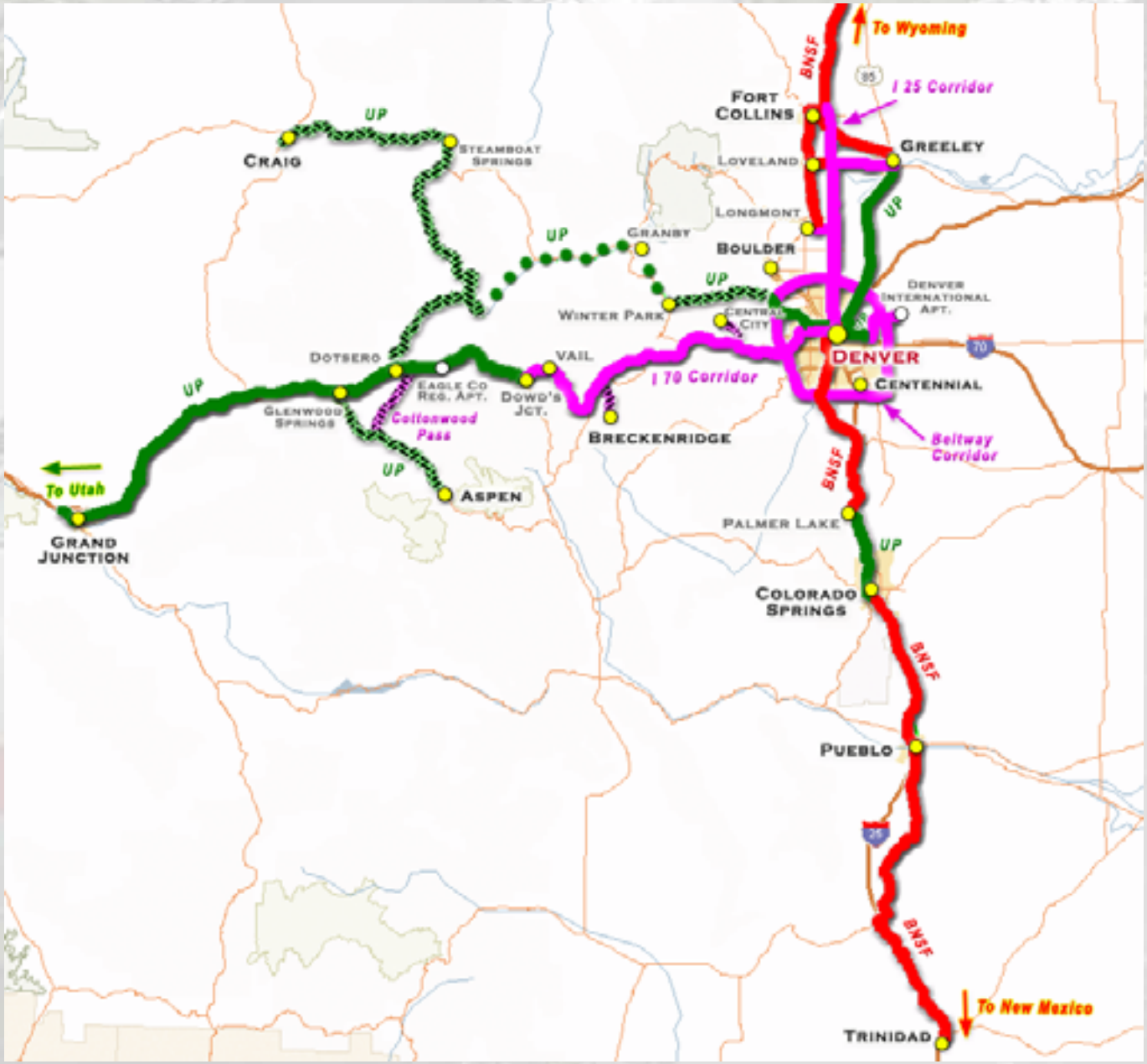
RMRA Study Corridors to be evaluated

Potential Passenger Rail Corridors to be studied



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Engineering Challenges & Developing Alignments

View West toward Base of Floyd Hill and US 6 Interchange Milepost 244

View East toward Twin Tunnels Milepost 242

View West over Straight Creek Milepost 213.5

View West over Wolcott Curve Milepost 155

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Task 4.3: Technology Database

- The technology database will be developed by reviewing the results of previous studies, and soliciting information from manufacturers to update TEMS existing databank.
- It is anticipated that the focus will be on a wide range of high speed technologies from 90 to 125 mph, but will also consider the potential for new technologies to provide higher speeds.

125 mph-T21

150 mph-Acela

185 mph-ICE

300 mph-Maglev

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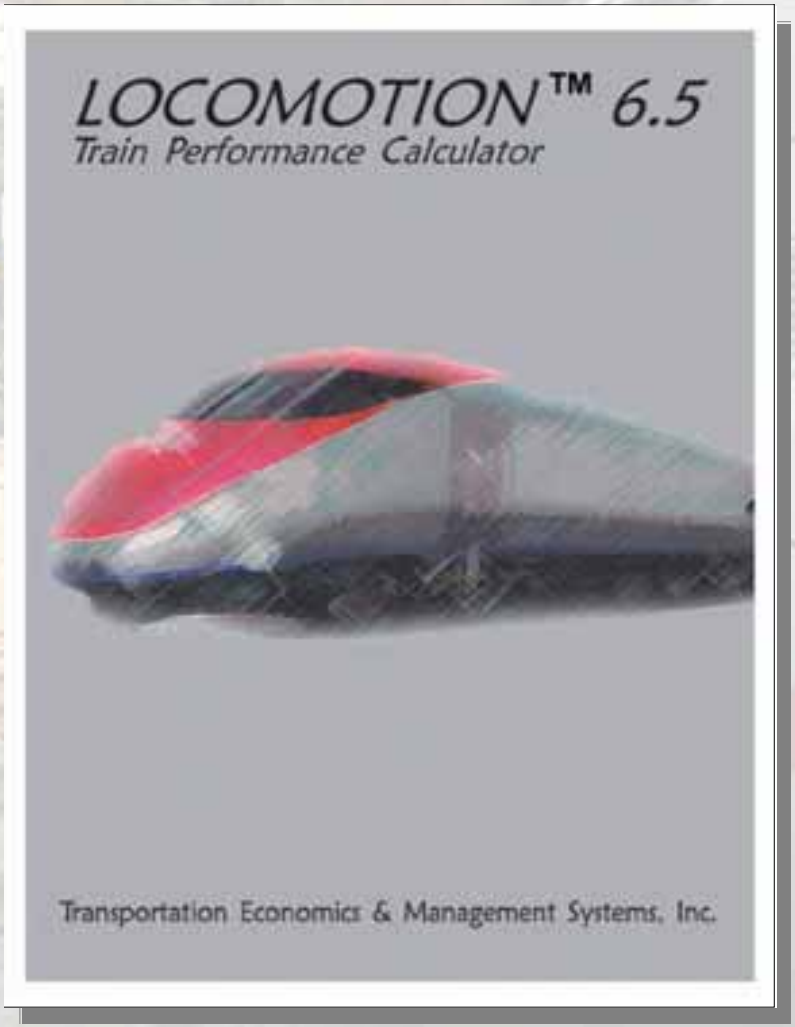
LOCOMOTION™ will estimate Train Speeds and Timetables



- **LOCOMOTION™** generates optimized timetables for given track infrastructure, signaling systems, and train technologies. It provides milepost-by-milepost graphic output of train performance based on track characteristics and shows the effect on timetables for improving the track, using a different technology.
- Because **LOCOMOTION™** takes account of other passenger and freight traffic using a right-of-way, it can develop stringline diagrams and identify the optimum train path for a new service.

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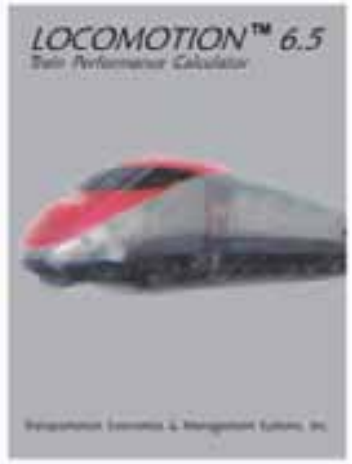
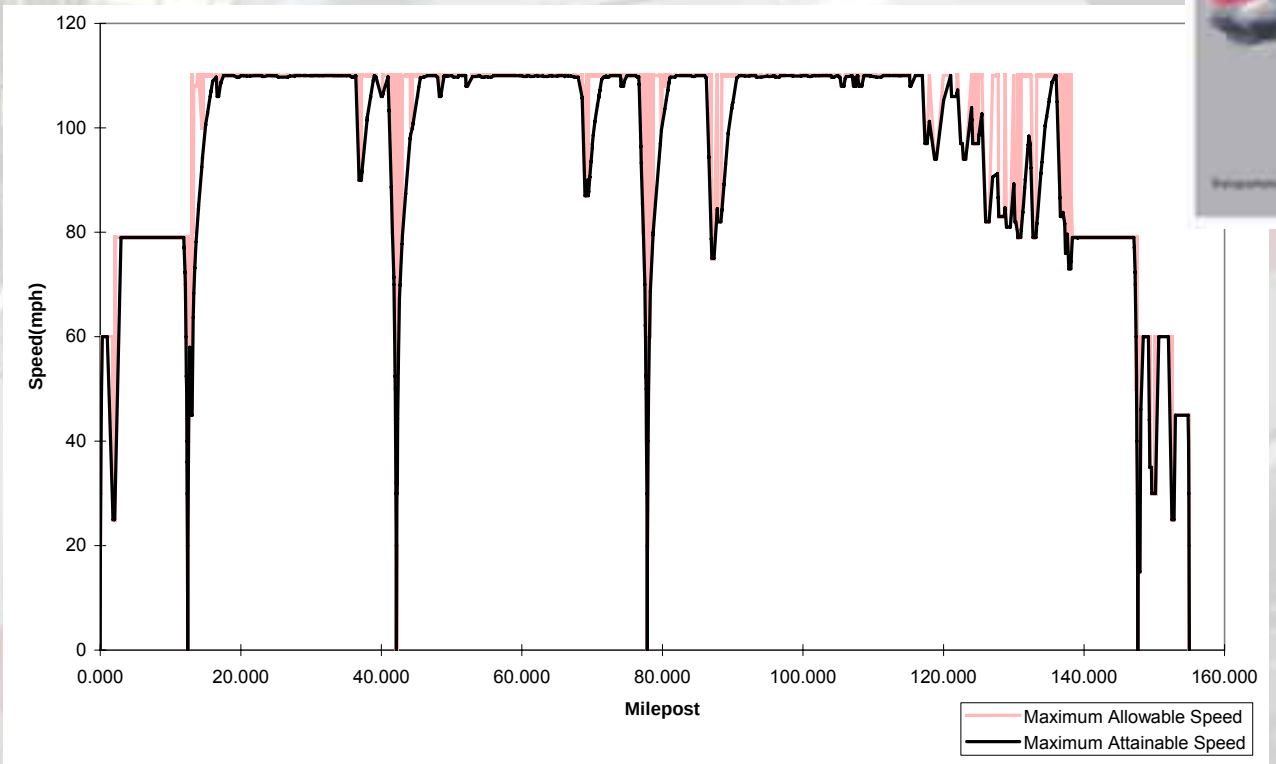
LOCOMOTION™ will be used to assess all the different technologies

Speed Profile – Minneapolis to Duluth
110-mph service -- 2:00 schedule





110-mph, 125-mph, 150-mph, 185-mph and 300-mph scenarios to be developed by the study

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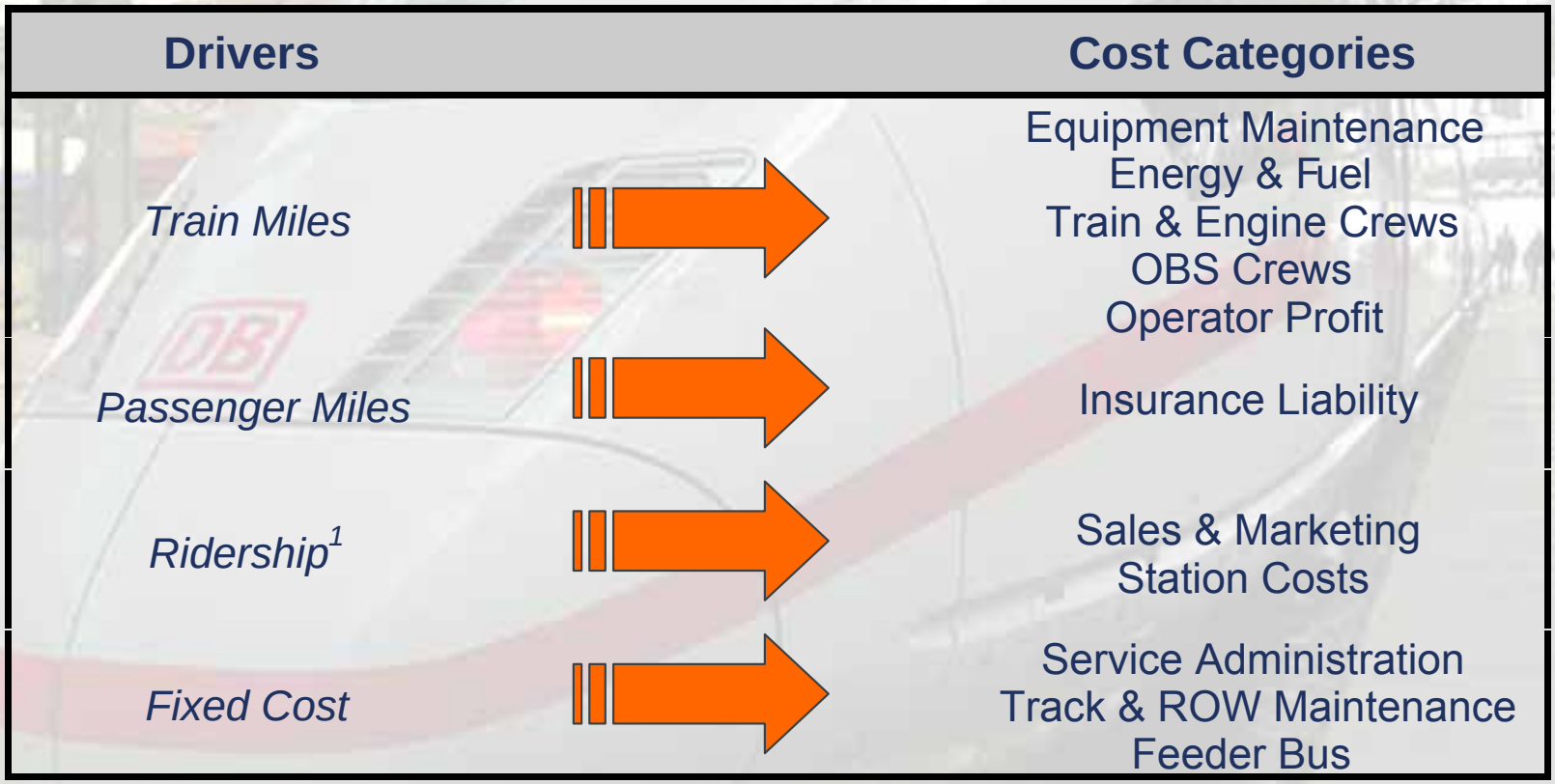
We will estimate Rail Operating Costs

Framework resulted from previous multi-year, multi-state planning efforts (e.g., MWRRI and Florida Business Plans)



[1]Station costs as well as sales and marketing are only affected weakly by ridership, so these two costs can be considered fixed for practical purposes.

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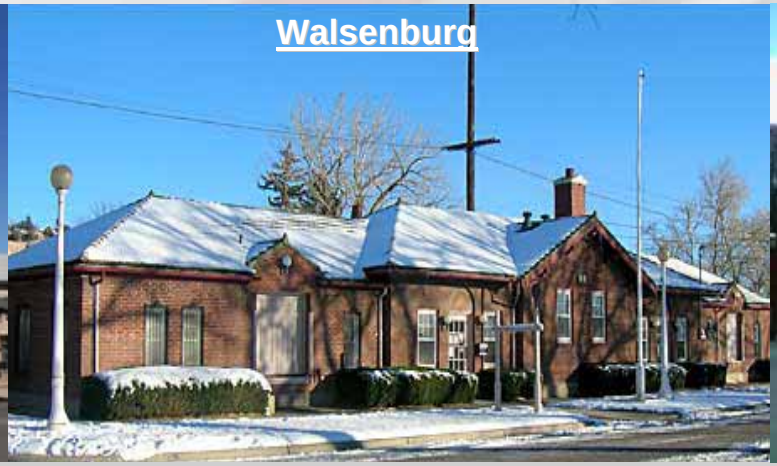
Task 4.4: Station and Property Database

- A property database will be developed for the corridors, which will assess existing properties along the rail line.
- The analysis will identify whether the property is residential, non-residential including commercial, industrial, vacant, agricultural, natural resources.
- An inventory of property values will be derived from state and federal property valuation sources (i.e., Colorado Division of Property Taxation and U.S. Department of Commerce-BEA Statistics).

Denver Union Station

Walsenburg



Glenwood Springs

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Task 4: Deliverables

For this task, the TEMS Team will prepare:

- **Methodology technical report** to be submitted at the start of this task in support of the Peer Review Panel meetings (including outreach, ridership and revenue forecasting, cost estimating, alternatives development, and alternatives analysis)
- **Existing Conditions technical report** (including opportunity to upgrade existing track to accommodate high speed passenger rail service)

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Task 5: Define Preliminary Service Scenarios for the I-70 and Front Range Corridors

Business Plan Step 2: Formulation of Rail Service Scenarios

In this task, the potential infrastructure and operations alternatives will be assessed in relation to the market demand for services to develop a set of potential alternatives.

Development of Initial Service Concepts

- **Base Level Service Concept** – a base level service operating within the context of a "stand alone" service.
- **Improved Service Concepts** – service improvements that would be associated with a refined level of engineering and operation considerations given the character of the market.

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Task 5: Deliverables

Alternatives Development Workshop

- The TEMS Team will lead alternatives development workshops for each primary corridor with the RMRA board, to reach consensus on the range of alternatives to be carried into alternatives evaluation.

Peer Review Panel Evaluation of Selected Alternatives

- Following the Alternatives Development Workshop, the Peer Review Panel will be convened to review and evaluate the alternatives.

Alternatives Development technical report

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Task 6: Alternatives Analysis

(Business Plan Step 3: Interactive Analysis and Business Plan Step 4 Systems Forecasts and Outputs)

The Interactive Analysis is designed to develop the most efficient and effective alternatives for passenger rail service in the RMRA Corridors. In these tasks, ridership and revenue are assessed against infrastructure needs and costs, and operating requirements and costs.

- **To effectively predict the change pattern and overall rail travel demand levels for new rail systems, models are needed that can accurately forecast the impact of trip making increases and the role of the rail mode.**
  - **Ridership and Revenue Forecasts**
  - **Evaluation of Alternatives**
  - **Operating and Capital Costs**

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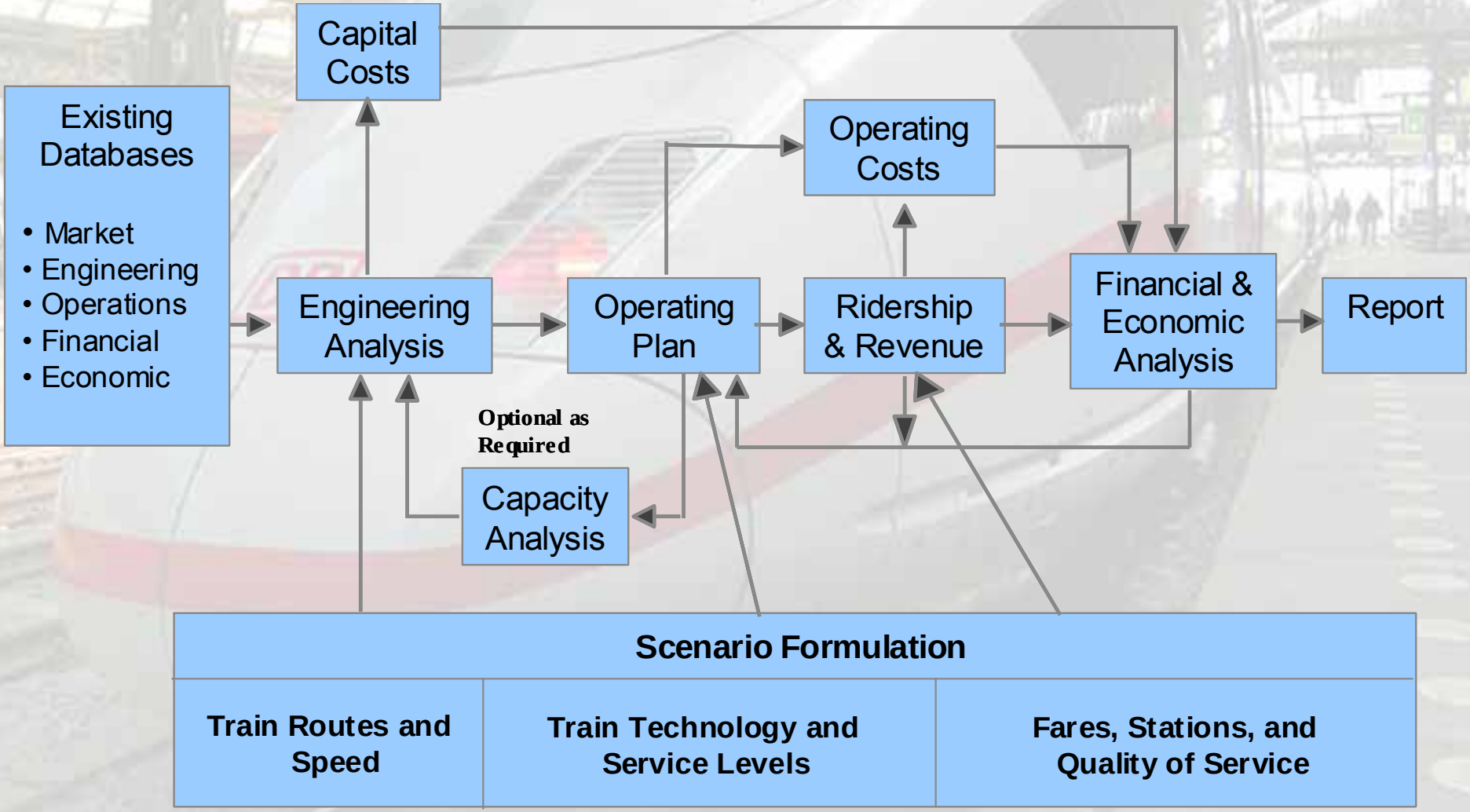
The key to the Business Planning process is the Interactive Analysis

Methodology for developing an optimized plan



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Task 6: Deliverables

- Ridership and Revenue Forecasts technical report
- Alternatives Analysis technical report (to include technology, operating, and cost assumptions)

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Task 7: Feasibility Determination

Business Plan Step 5: Assess both Institutional and Financial Plan Options

To provide a clear understanding of the value of different alternatives and route investments, the TEMS Team will carry out the follow-up analysis:

- **Comprehensive financial analysis including cash flows**
- **Comprehensive user benefits (consumer surplus) and non-user benefits analysis**
- **Community analysis (Economic Rent) identifying jobs, income, property values**

In addition, the TEMS Team will identify institutional and financing arrangements for the project.

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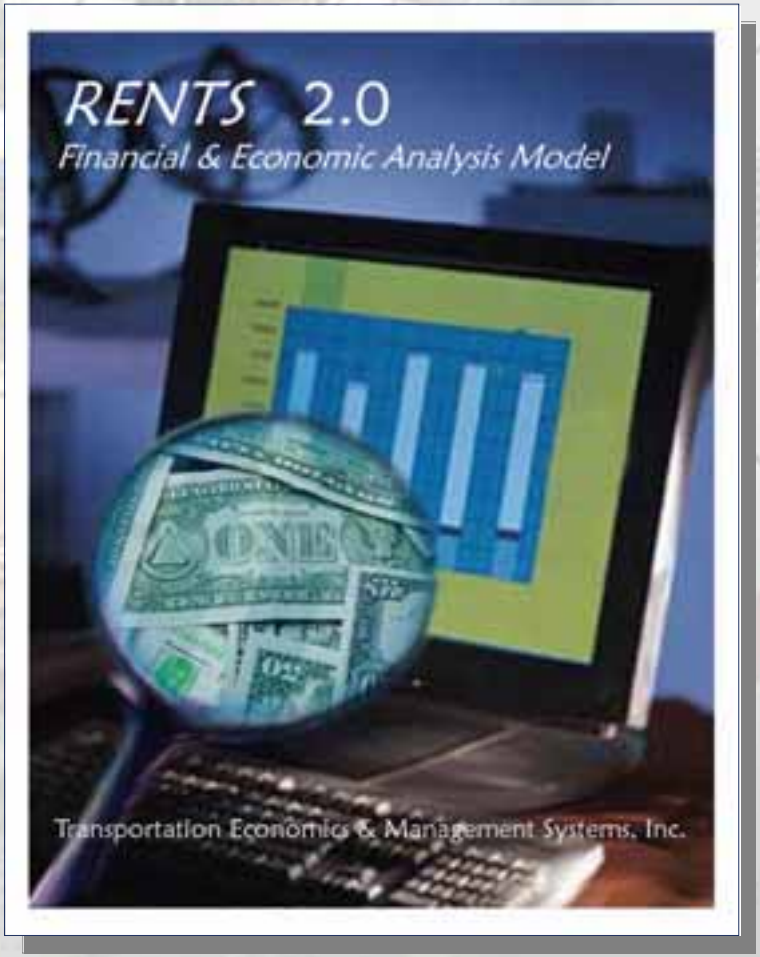
RENTS™ will determine what technology and routes are financial and economically feasible and meet FRA requirements



RENTS™ uses output from the COMPASS™ Demand Forecasting System to estimate the financial and economic benefits of a project:

- **Financial return (Operating Ratio, NPV and IRR)**
- **Economic return (Gross and Net Consumer Surplus, NPV, and Cost-Benefit Ratio), and**
- **Economic Rent (Community benefits, such as changes in household income, employment by sector, property values, and population)**

that result from infrastructure and technology improvements or timetable and fare modifications.

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We will provide Pro forma Financial Analysis Of Cash Flows

Duluth Corridor Example

Exhibit 7.7 Minneapolis to Duluth 110-mph Rail Service: 8-Train Base Plan - Preliminary Operating Statement

Thousands of 2006 $	Total to 2040	2012	2013	2014	2015	2016	2017
Revenues							
Ticket Revenue	**$1,080,230**	$13,567	$25,107	$28,659	$29,422	$30,185	$30,948
On Board Services	**$86,418**	$1,085	$2,009	$2,293	$2,354	$2,415	$2,476
Express Parcel Service (Net Rev)	**$54,011**	$678	$1,255	$1,433	$1,471	$1,509	$1,547
Total Revenues	**$1,220,660**	$15,331	$28,371	$32,385	$33,247	$34,109	$34,971
Train Operating Expenses							
Energy and Fuel	**$75,081**	$2,013	$2,013	$2,013	$2,013	$2,013	$2,013
Train Equipment Maintenance	**$204,890**	$5,494	$5,494	$5,494	$5,494	$5,494	$5,494
Train Crew	**$96,367**	$3,323	$3,323	$3,323	$3,323	$3,323	$3,323
On Board Services	**$80,631**	$1,833	$2,295	$2,437	$2,467	$2,498	$2,528
Service Administration	**$147,171**	$5,075	$5,075	$5,075	$5,075	$5,075	$5,075
Total Train Operating Expenses	**$604,139**	$17,738	$18,200	$18,342	$18,372	$18,403	$18,434
Other Operating Expenses							
Track & ROW Maintenance	**$114,663**	$3,954	$3,954	$3,954	$3,954	$3,954	$3,954
Station Costs	**$40,547**	$1,398	$1,398	$1,398	$1,398	$1,398	$1,398
Sales & Marketing	**$51,009**	$643	$1,190	$1,358	$1,394	$1,429	$1,465
Insurance Liability	**$43,345**	$549	$1,015	$1,158	$1,188	$1,218	$1,248
Total Other Operating Expenses	**$249,564**	$6,544	$7,557	$7,868	$7,934	$7,999	$8,065
Total Operating Expenses	**$853,703**	$24,283	$25,757	$26,210	$26,306	$26,402	$26,498
Cash Flow From Operations	**$366,957**	($8,952)	$2,614	$6,175	$6,941	$7,707	$8,473
Operating Ratio	**1.43**	0.63	1.10	1.24	1.26	1.29	1.32

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We will measure USDOT FRA approved economic benefits

MWRRS Example

Benefits	Billions in 1998 dollars
MWRRS User Benefits	
Consumer Surplus	$6.4
(e.g., time savings expressed as dollars)	
System Revenues	$6.8
Other Mode User Benefits	
Airport Congestion Relief	0.7
Highway Congestion Relief	1.3
Resource Benefits	
Air Carrier Operating Cost Reductions	0.4
Emission Reductions	0.3
Total Benefits	**$15.9**
Costs	
Capital	$4.1
Financing	0.2
Operating and Maintenance	5.0
Total Costs	**$9.3**
Ratio of Benefits to Costs	**1.7**

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Will Estimate Community Benefits

Duluth Corridor Example

Economic Rent Factor	110/4	125/4	110/8	125/8
State of Minnesota:				
Employment (# productivity jobs)	5,647	6,409	13,114	13,876
Income (2006$)	$252 mill	$285 mill	$583 mill	$616 mill
State Income Tax 2006$)	$10.6 mill	$12.0 mill	$24.5 mill	$25.9 mill
Federal Income Tax (2006$)	$28.5 mill	$32.3 mill	$66.0 mill	$69.7 mill
Property Value (2006$)	$722 mill	$817 mill	$1,672 mill	$1,767 mill
Property Tax (2006$)	$ 8.4 mill	$ 9.5 mill	$ 19.5 mill	$ 20.6 mill
Average Household Income (2006$)	$167	$189	$384	$406
State of Wisconsin:				
Employment (# productivity jobs)	305	351	719	765
Income (2006$)	$15 mill	$17 mill	$34 mill	$37 mill
State Income Tax (2006$)	$0.5 mill	$0.6 mill	$1.2 mill	$1.3 mill.
Federal Income Tax (2006$)	$1.5 mill	$1.7 mill	$3.5 mill	$3.8 mill
Property Value (2006$)	$45 mill	$52 mill	$106 mill	$113 mill
Property Tax (2006$)	$ 0.8 mill	$ 0.9 mill	$ 1.8 mill	$ 2.0 mill
Average Household Income (2006$)	$102	$117	$240	$255

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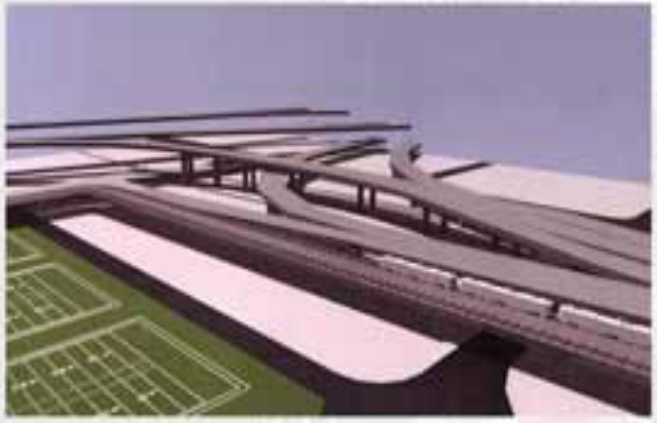
Cincinnati Joint Development Opportunity

Southeast Corner

East View



Joint Development Potential = $450 Million

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Task 7: Deliverable

Final Evaluation and Recommendation

Will identify an optimum high speed rail system alternative(s), with a clear rationale for the elimination of screened alternatives, and prepare a final evaluation of the feasibility of those system(s).

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Task 8: Documentation/Deliverables

Business Plan Step 6: Implementation and Business Plan

For the selected alternative(s):

- **Implementation plan**
- **Business plan**

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We will develop an Implementation Plan

Ohio-Cleveland Hub	$ 1000's of 2002$)	Year1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
3-C Corridor	$1,090,801		PE	Final Design		Construction		Operation			
Cleveland-Detroit	$387,101		PI	PE		Final Design		Construction		Operation	
Cleveland-Pittsburgh	$487,624			PI	PE		Final Design		Construction		Operation
Cleveland-Toronto	$803,996				PI	PE		Final Design		Construction	Operation

Total Investment Costs by Year		Year1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Planning and Implementation (PI)	$173,095	$68,175	$24,194	$30,477	$50,250						
Preliminary Engineering (PE)	$242,333	$15,908	$69,275	$45,600	$45,815	$54,011	$11,725				
Final Design	$276,952			$54,540	$73,895	$43,736	$64,581	$40,200			
Construction	$2,077,142				$102,263	$445,341	$497,665	$367,106	$438,643	$226,124	
Total Infrastructure	$2,769,522	$84,083	$93,469	$130,616	$272,222	$543,088	$573,971	$407,306	$438,643	$226,124	
Total Land	$233,209				$70,756	$57,930	$47,351	$57,172			
Total Rolling Stock	$322,000						$80,500	$80,500	$80,500	$80,500	
Total Investment	$3,324,731	$84,083	$93,469	$130,616	$342,978	$601,018	$701,822	$544,977	$519,143	$306,624	

Key to Implementation Stages	Key to Operation Phases:
Project Development	Phase 1
Preliminary Engineering	Phase 2
Final Design	Phase 3
Construction	Phase 4

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We will write a Business Plan

Feasibility Study Business Plan Report Layout

---	**Executive Summary**	Summary of the Business Plan for reference by senior decision-makers
Chapter 1	**Rocky Mountain Corridor Intercity Rail Services**	Summary of the overall systems to be developed
Chapter 2	**Target Markets and Proposed Service Offerings**	Detailed description of target markets, market segments, associated rail service offerings, fare structures, and proposed ancillary services
Chapter 3	**Projected Equipment and Capital Investment Needs**	Summary of equipment and capital investment needs for both the rail service itself and ancillary services
Chapter 4	**Operating Arrangements and Responsibilities**	Proposed operating arrangement and responsibilities including cooperative agreements, with freight railroads, private sector participation and public/private partnerships
Chapter 5	**Project Market Penetration, Patronage and Annual Revenues**	Estimated market penetration by city pair and target market segment, estimated annual patronage and annual revenues for the rail system and associated services
Chapter 6	**Estimated Operating Costs**	Projected annual costs including rail service and ancillary operating, equipment, capital and debt service costs
Chapter 7	**Financing Plan and Innovative Financing Options**	Proposed financing plan including projected private sector contributions. Proforma Financial Statements
Chapter 8	**Legal, Regulatory and Institutional Requirements**	Assessment of critical legal, regulatory and institutional issues, including recommendations for potential action
Chapter 9	**Potential for Added Revenue and Cost Reduction**	Identification of potential innovative service arrangements, ancillary service offerings and potential operating procedures designed to either enhance revenue or reduce costs
Chapter 10	**Service Implementation Plan**	Description of the proposed rail service implementation program, by year and region together with the marketing program, institutional arrangements, and legal and financial agreements
Chapter 11	**Business Plan**	Comprehensive Business Plan assessment of the proposed rail system, and assessment of the risk associated with its implementation
----	**Appendices**	Detailed data tabulations supporting individual chapters
----	**Presentation Materials**	PowerPoint™ Presentation to be given to executives and senior decision-makers

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Thank You

APPENDIX B: UTILITY CONTACTS

There may be potential for partnerships with electric utilities as HSR through the Rocky Mountains has been identified as a potential opportunity to expand electrical transmission capacity. Panel member, David Muñoz, has contacts with relevant utility representatives (listed below) in the I-70 mountain corridor.

Contact Name	Affiliation	Phone
Tim Knowlton	Xcel Energy, Responsible for acquiring land right of way, natl. gas side	303-571-3402
Andy Schaller	Xcel Energy, Unit Mgr. Of Engineering, Electric Transmission	303-571-7602
Mike Miller	Xcel Energy, Gas Planning Engineer	303-571-3128
Sandra Johnson	Xcel Energy, Supervisor of electrical planning group	303-571-7095
Bill Anderson	EXCEL Energy	303-571-7273
Bob Easton	Western Area Power Admin. (WAPA)	970-461-7272
Frank McElvain	Tri-State Power	303-452-6111
John Work	WAPA	720-962-7377

Last updated in 2002

"Urban Maglev Technology Development Program, Colorado Maglev Project", Report to the Federal Transit Administration, USDOT, FTA-CO-26-7002-2004, June 2004. http://www.dot.state.co.us/publications/maglev/maglev.htm (accessed November 25, 2008)

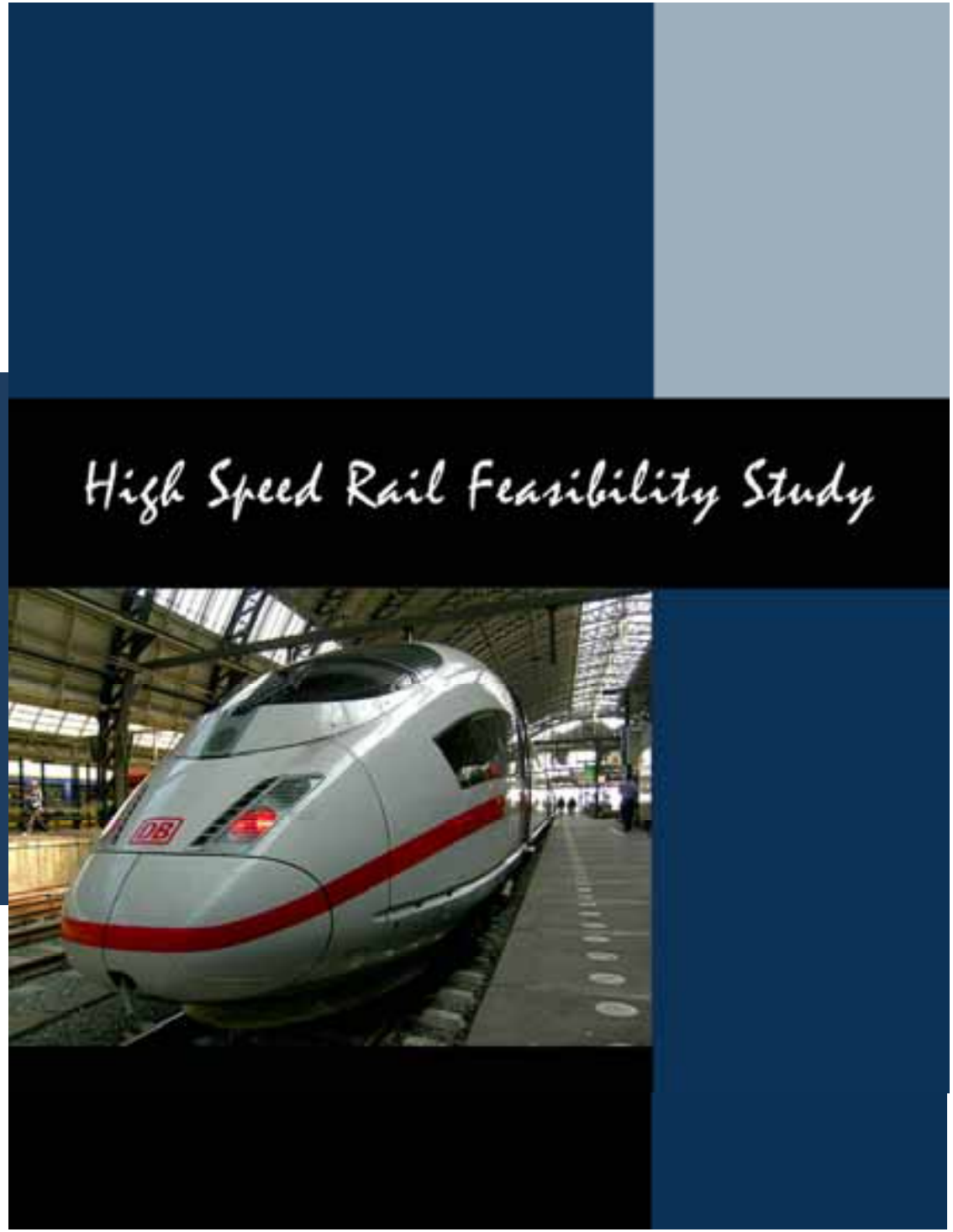
APPENDIX C: RIDERSHIP PRESENTATION

Presentation To

RMRA Peer Panel Workshop – Day #1

Market Analysis

November 19, 2008



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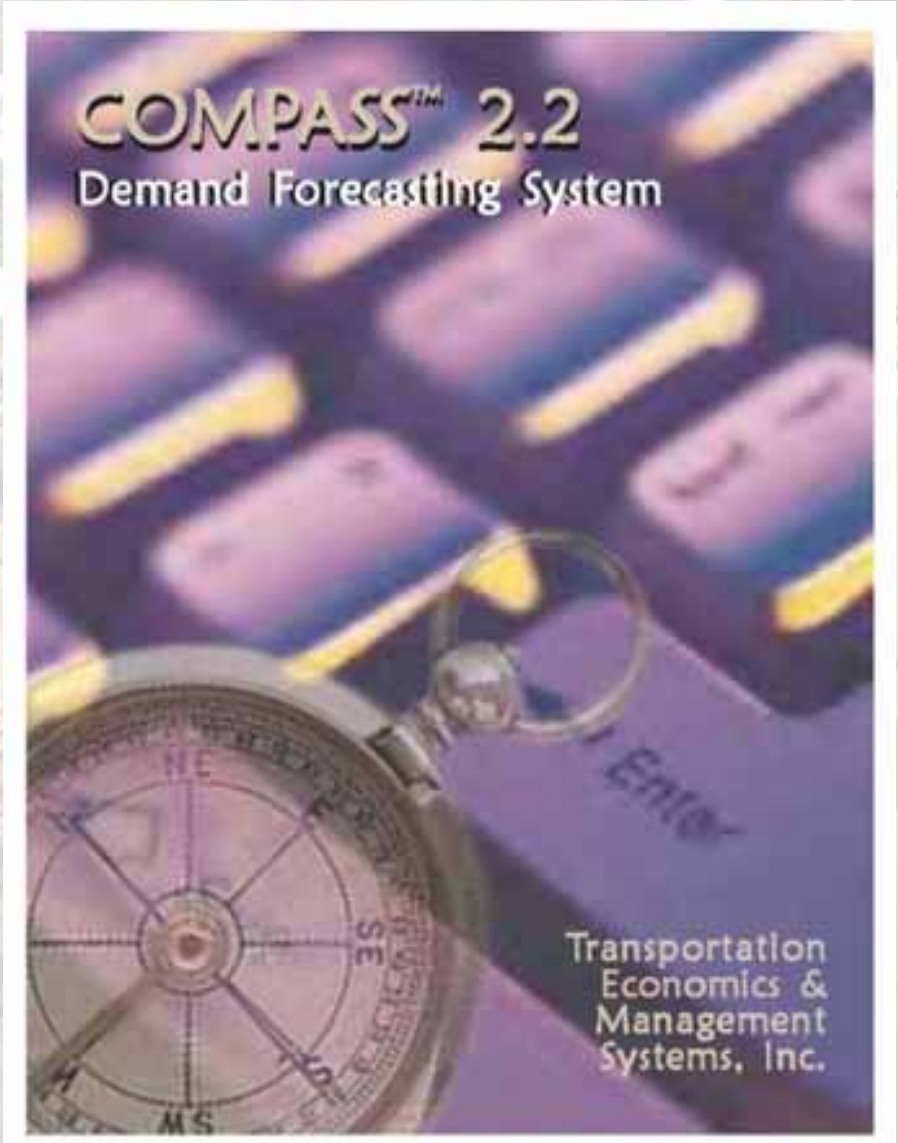
COMPASS™ Demand Forecasting System



COMPASS™ is a comprehensive strategic policy planning tool to assist rail, highway, air, and transit management in planning their systems. It generates ridership and revenue forecasts for any set of socioeconomic, network, and competitive mode conditions. Outputs include traffic forecasts; revenue estimates; and rail, highway, air, and transit market shares over a given timeframe for a variety of conditions.

The COMPASS™ model consists of a three-step analysis process that estimates:

- **Total market growth by mode (air, rail, bus, auto) and travel purpose**
- **Induced demand due to changes in quality of service offered by any mode**
- **Modal Split / Route Split for estimating market or route shares using a hierarchical mode choice analysis.**

A key metric of the COMPASS™ model is "generalized cost." The generalized cost function allows time, cost, frequency, and service attributes to be combined into a single metric that can show how changes in speed, frequency, or fare will affect the use and market share of any mode.

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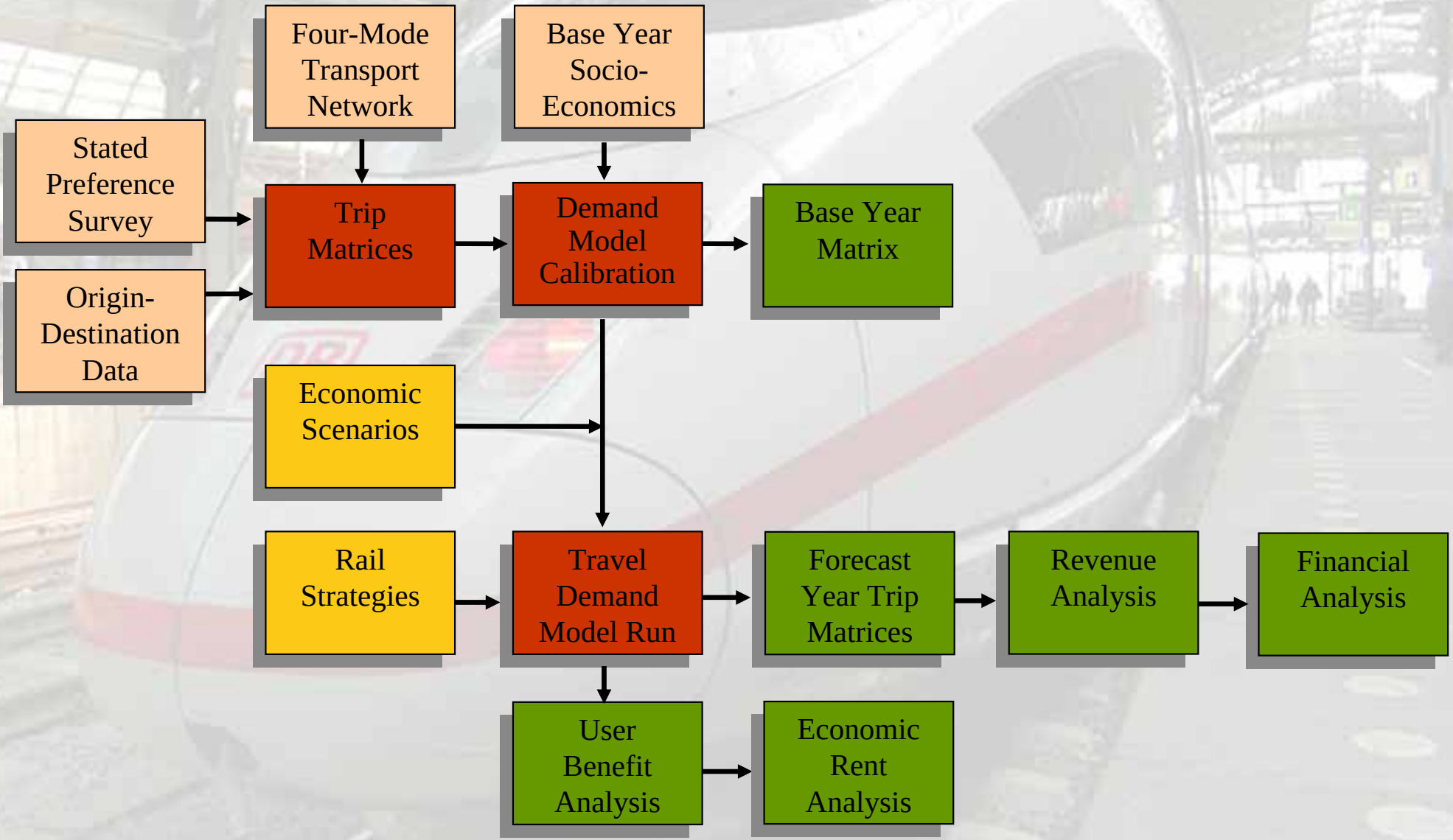
COMPASS™ Model Structure



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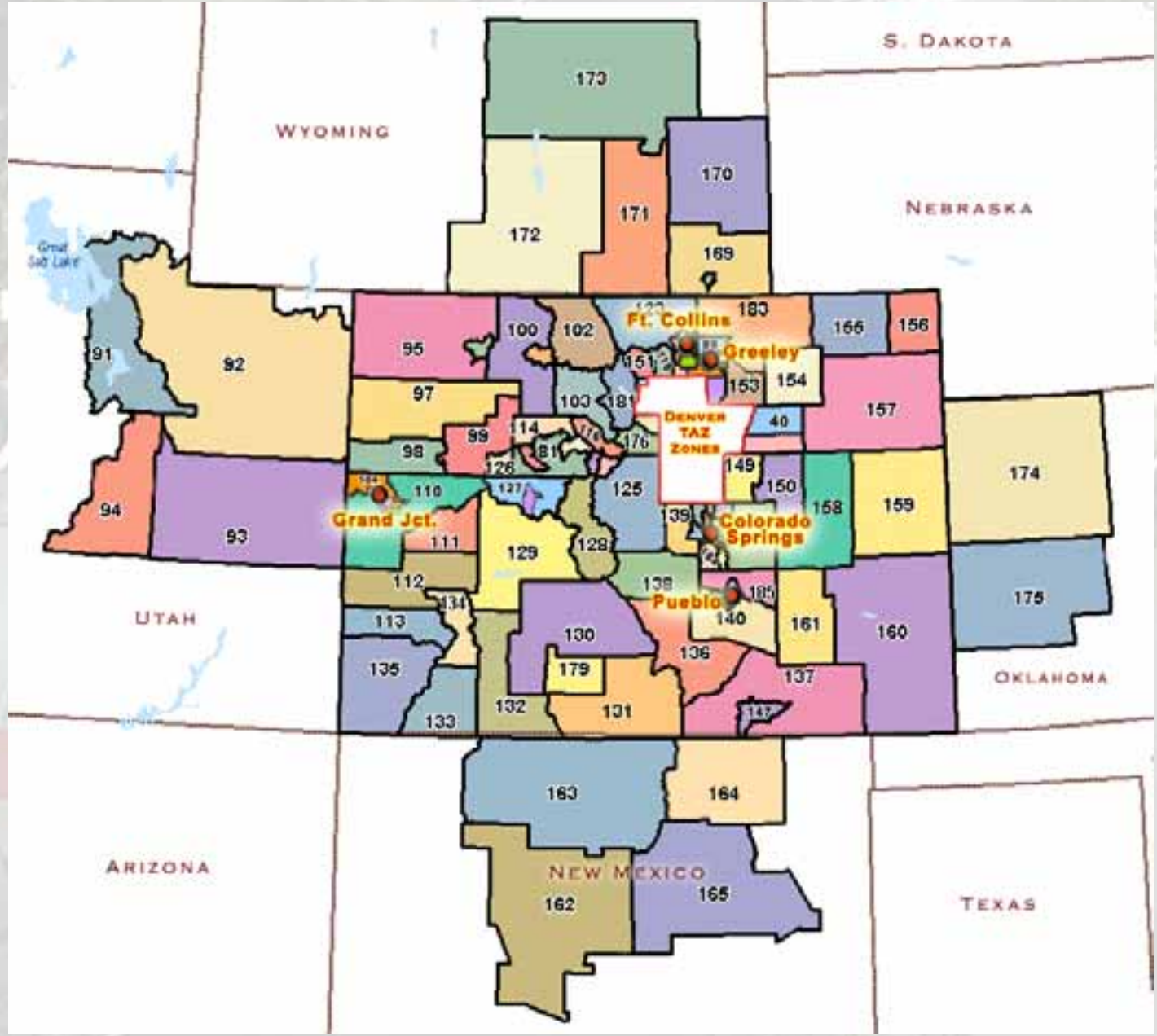
Zone System



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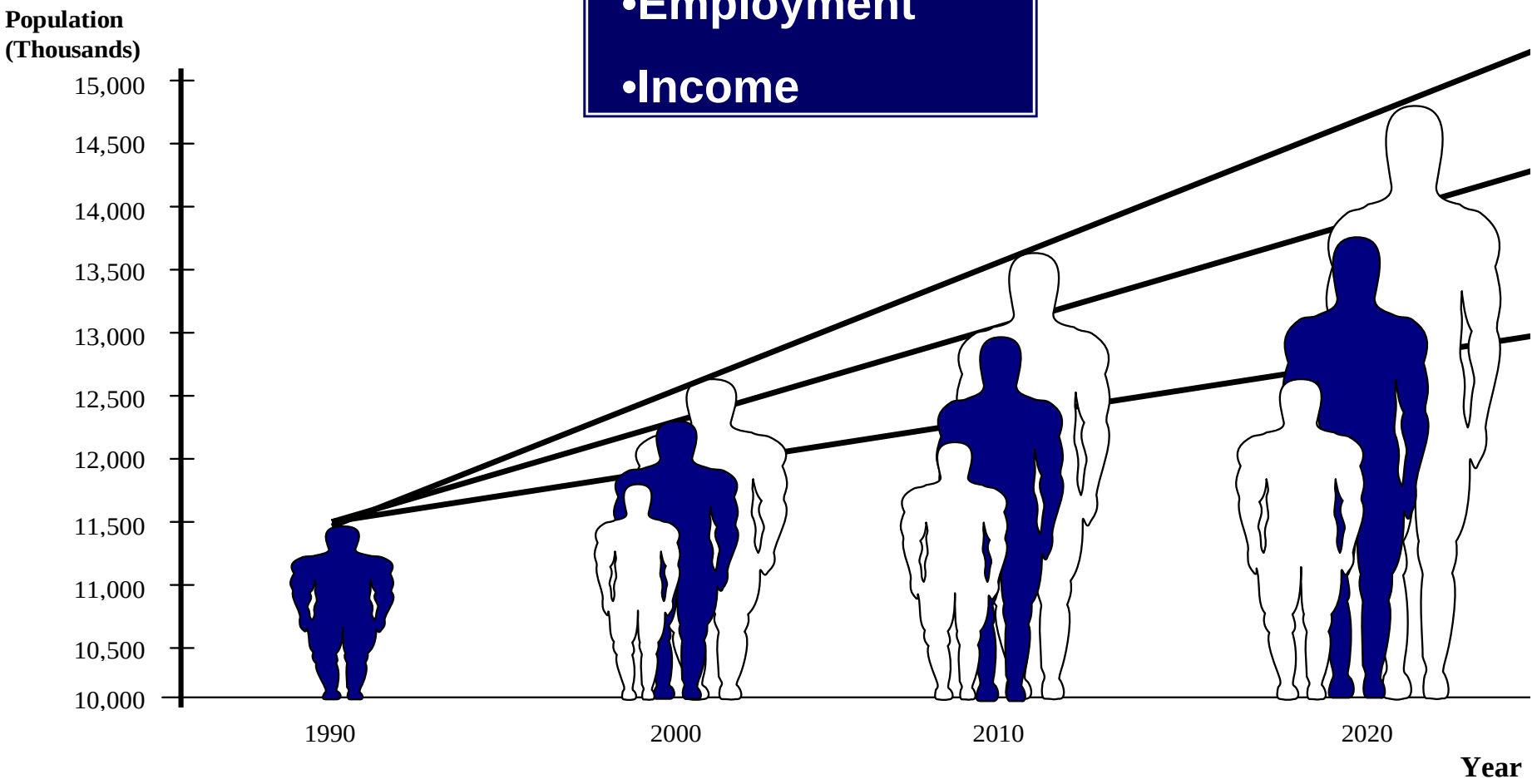
Socioeconomic Projections

- Population
- Employment
- Income



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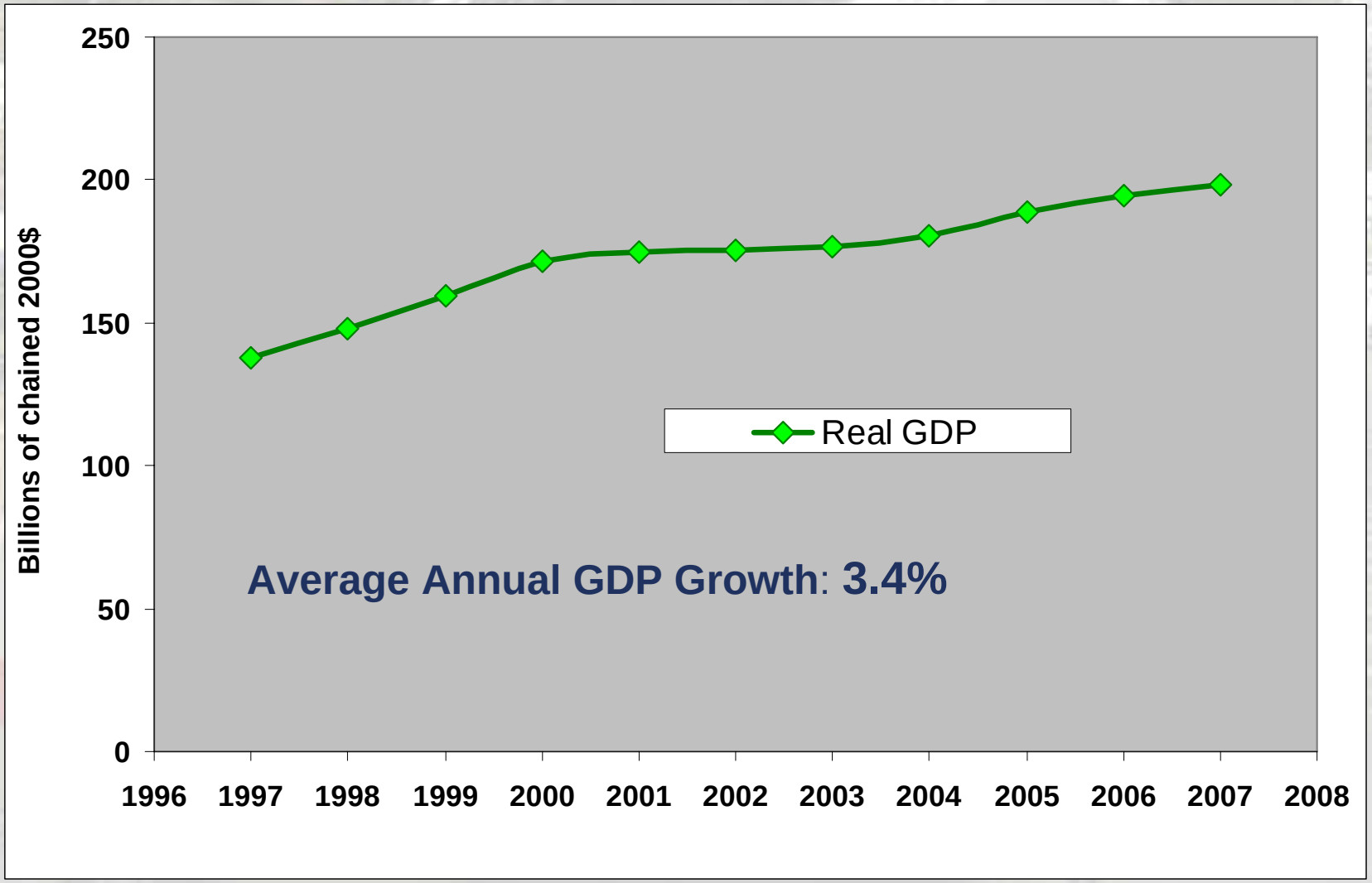
State of Colorado Real GDP (1997-2007)



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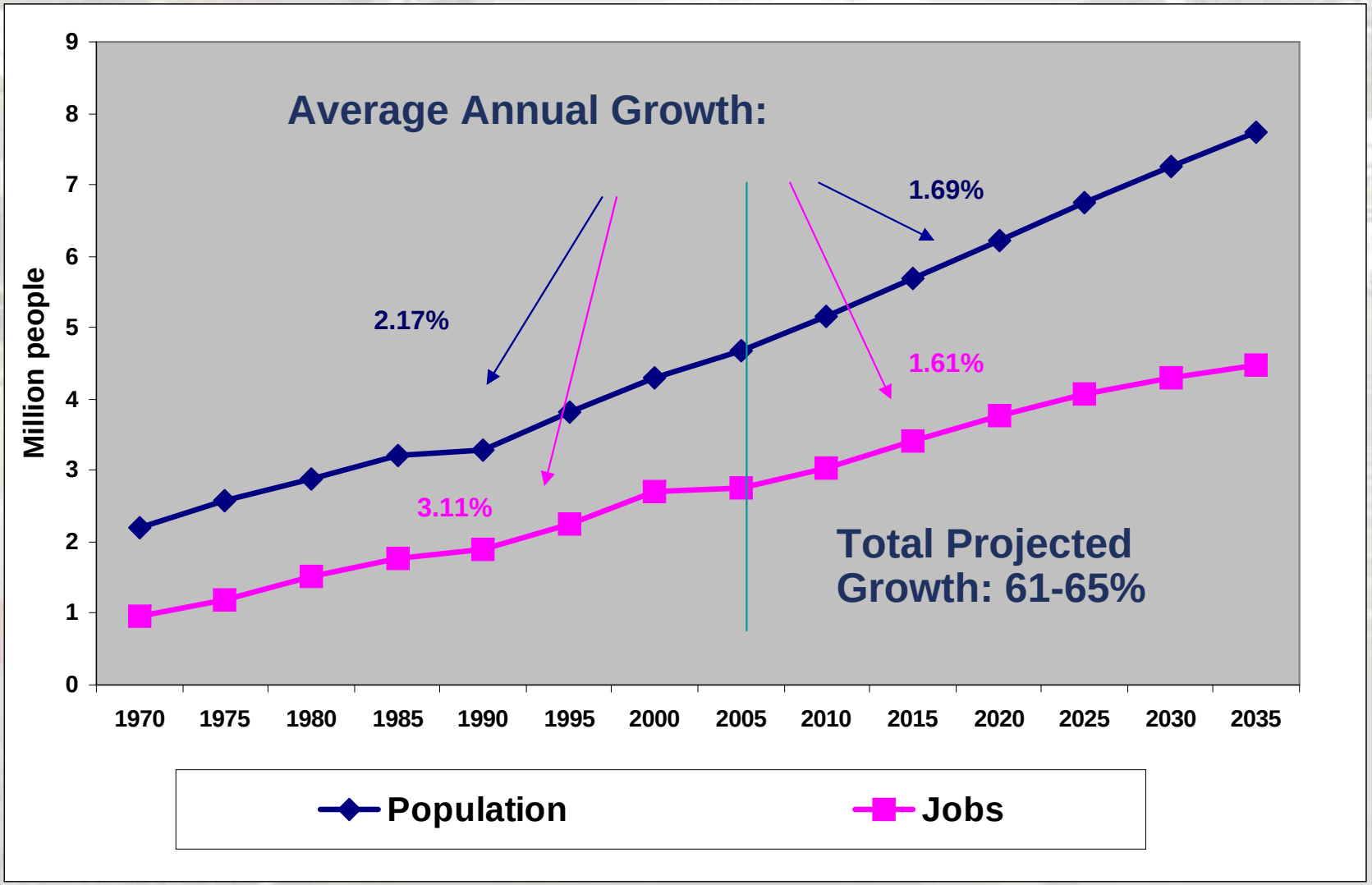
Population and Labor in the State of Colorado (1970-2035)



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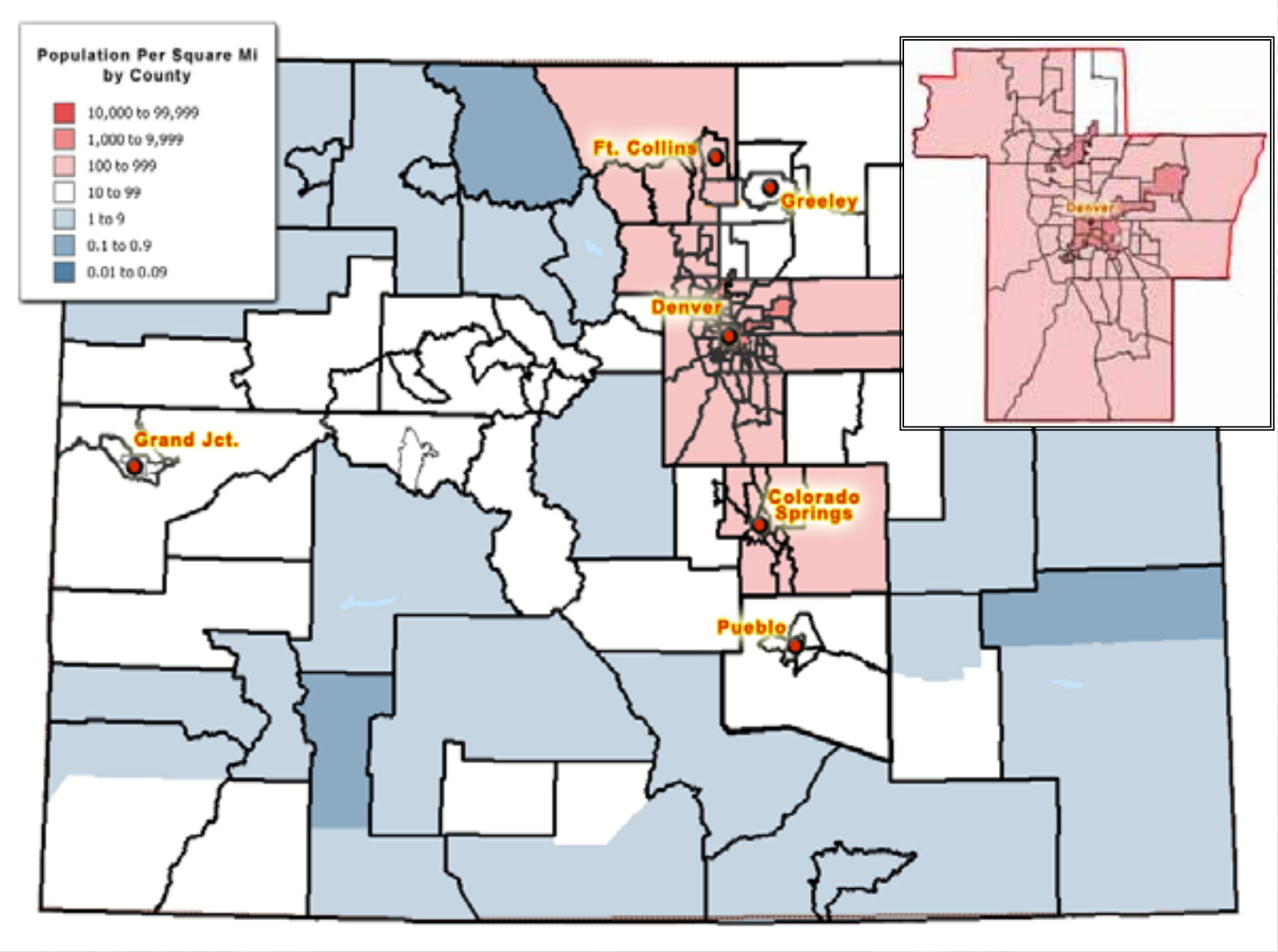
Colorado Population Density



Source: Microsoft MS MapPoint 2006 demographic data provided by Applied Geographic Solutions.

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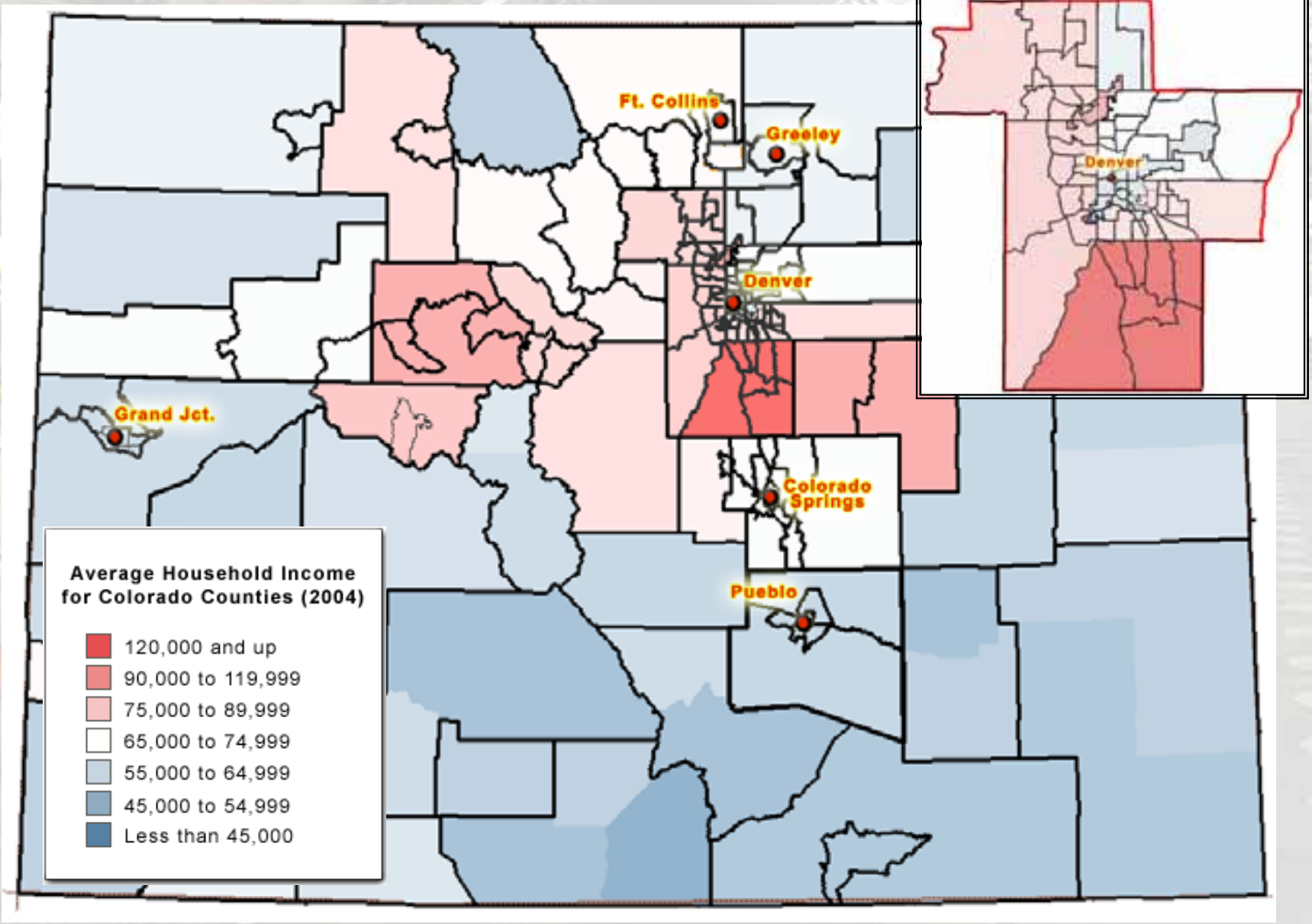
Colorado Household Income



Source: Microsoft MS MapPoint 2006 demographic data provided by Applied Geographic Solutions.

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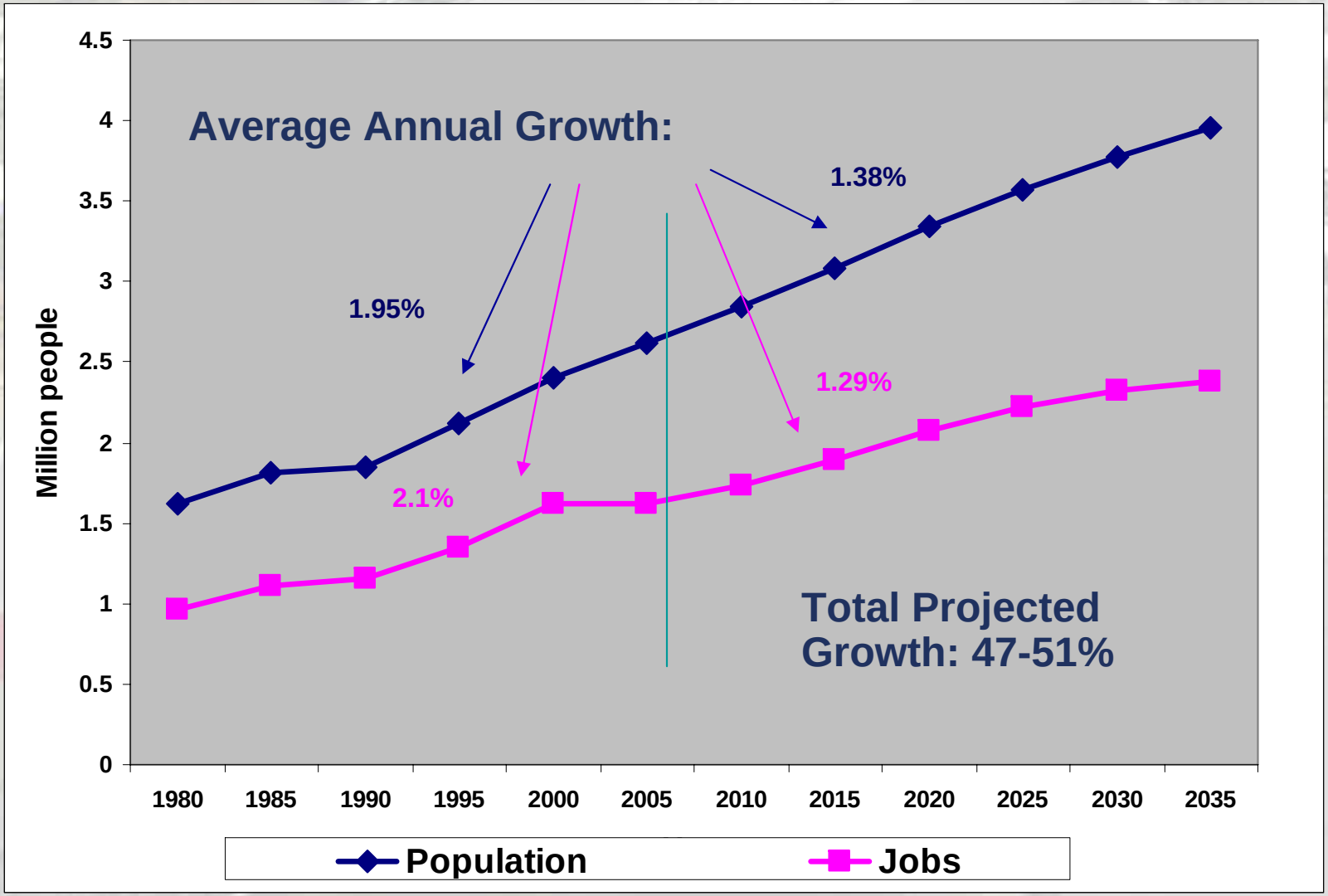
Population and Labor in the Denver Metro Area (1980-2035)



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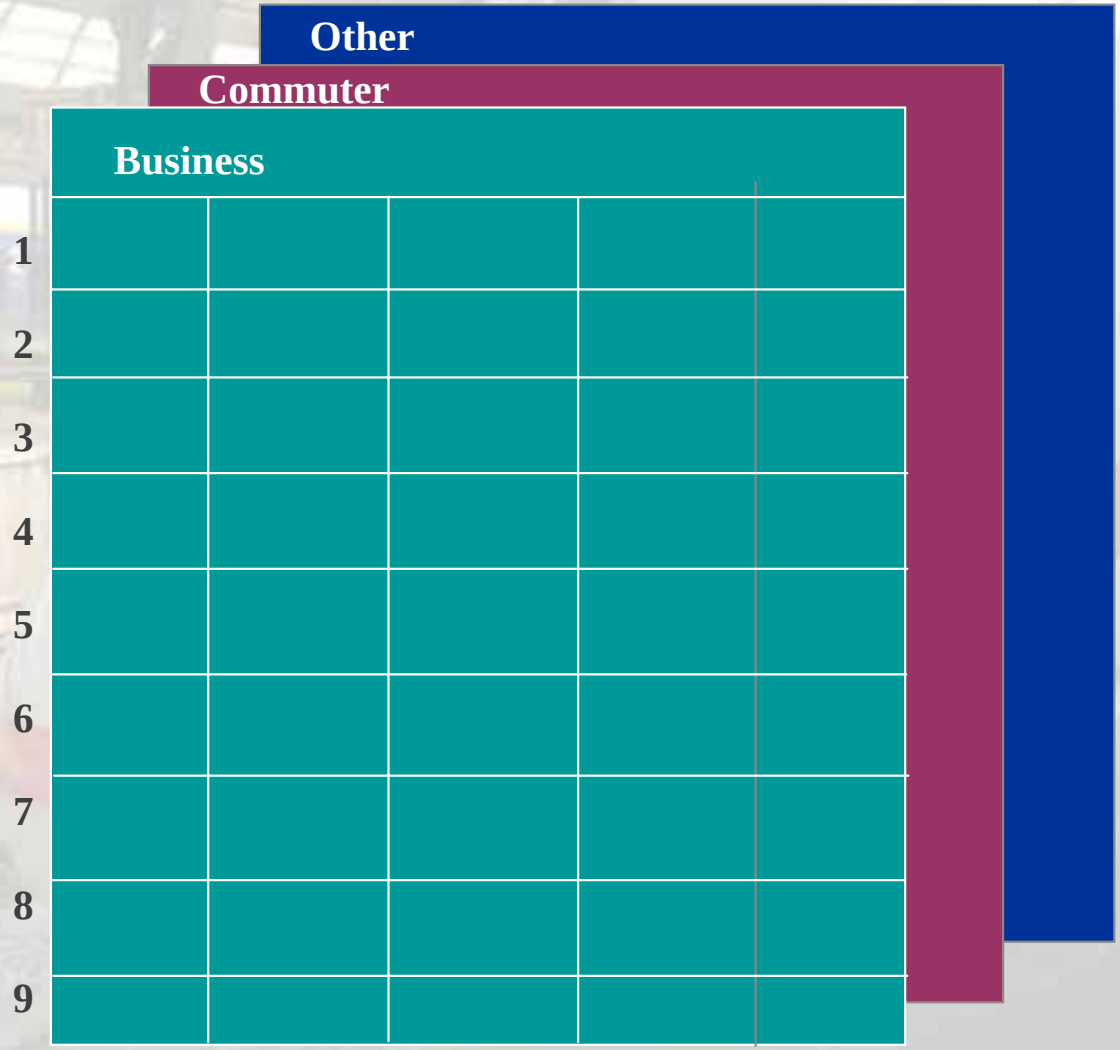
We will build a Sound and Comprehensive Database



"Using MPO and Stated Preference Data to create a sound behavioral database for passenger rail planning"

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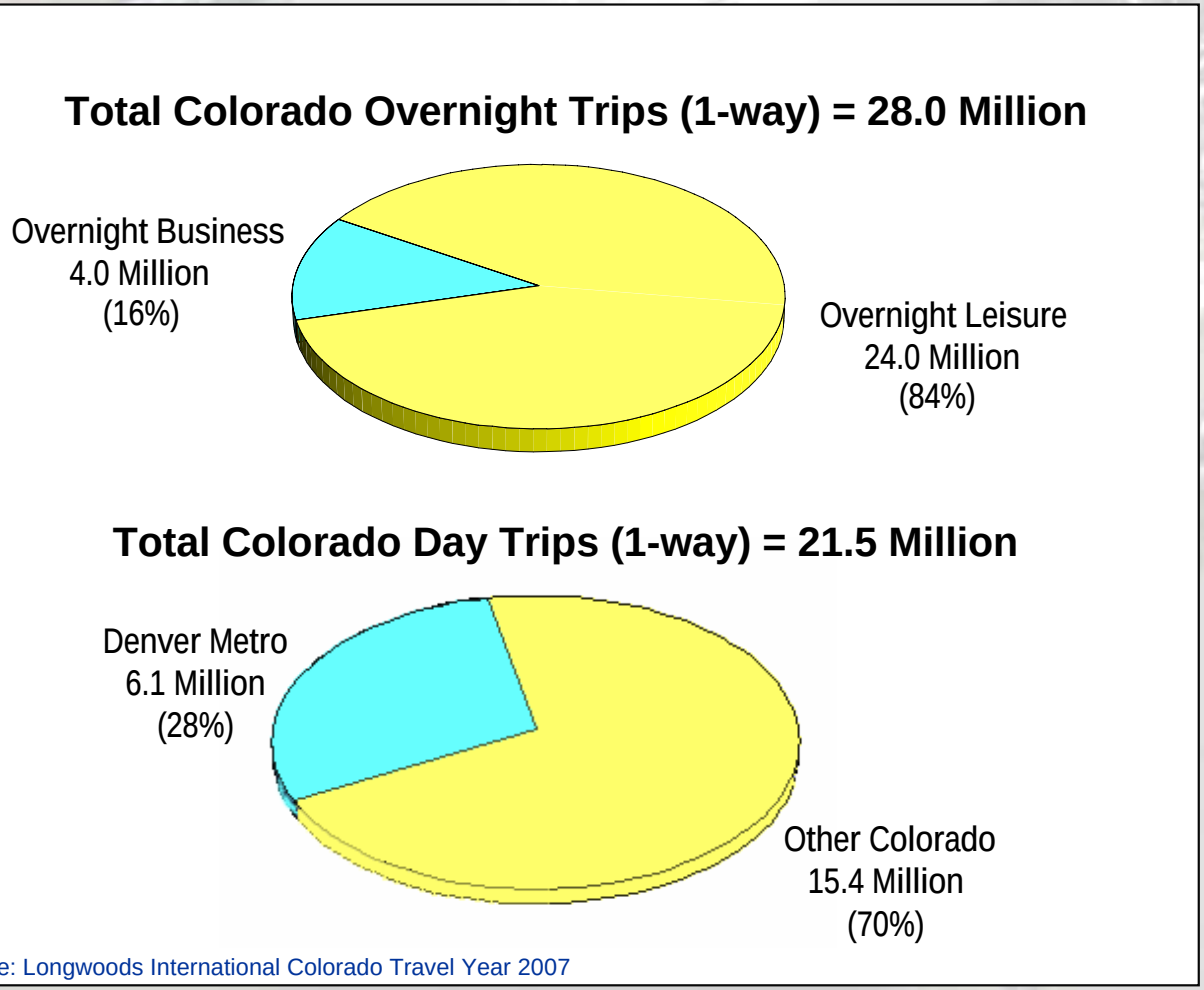
Overnight and Day Trips in Colorado 2007



Source: Longwoods International Colorado Travel Year 2007

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Colorado Skier Visits

colorado
SKI COUNTRY USA

	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Destination Resorts										
Aspen Highlands	142,090	127,389	140,640	136,136	157,317	160,836	167,390	193,242	193,648	211,635
Aspen Mountain	334,536	331,121	319,343	310,381	315,130	298,830	304,495	324,465	328,002	337,774
Buttermilk	178,089	158,194	148,826	145,683	141,077	139,213	148,012	159,081	153,957	154,926
Crested Butte	462,478	414,642	367,263	336,483	342,416	333,011	375,936	411,729	366,765	416,009
Cuchara	21,678	32,154	DNO	DNO	DNO	DNO	DNO	DNO	DNO	DNO
Durango	304,735	235,000	321,600	250,500	263,712	268,486	278,767	211,003	251,794	278,994
Howelsen Hill	14,475	14,000	14,000	15,208	14,000	14,009	16,526	18,423	17,054	20,126
Silverton Mountain	DNO	DNO	DNO	DNO	2,382	3,600	3,683	3,900	5,569	6,000
Snowmass	777,140	707,600	740,241	676,505	669,701	724,752	747,293	768,007	770,407	771,455
Steamboat	1,013,254	1,024,832	1,003,317	1,001,003	1,001,020	1,002,821	971,770	1,046,650	1,071,786	1,022,193
Telluride	382,467	309,737	334,506	341,370	367,252	367,775	411,396	390,346	426,244	450,730
Wolf Creek	202,053	114,802	187,116	170,847	183,907	210,857	215,821	197,052	222,979	195,583
Total Destination	3,832,995	3,469,471	3,576,852	3,384,116	3,457,914	3,524,190	3,641,089	3,723,898	3,808,225	3,865,427
Front Range Destination										
Beaver Creek	614,549	586,004	676,528	657,956	718,353	768,542	815,350	875,455	889,812	917,863
Breckenridge	1,385,927	1,444,365	1,422,783	1,468,518	1,424,770	1,402,055	1,470,961	1,619,043	1,650,321	1,630,106
Copper Mountain	867,394	803,312	992,888	1,005,913	1,058,016	931,143	1,046,242	1,132,021	1,046,959	934,870
Keystone	1,253,192	1,192,198	1,230,100	1,069,111	1,038,942	944,433	1,021,069	1,093,939	1,170,710	1,129,608
Vail	1,334,939	1,371,702	1,645,902	1,536,024	1,610,961	1,555,513	1,568,192	1,676,119	1,608,204	1,569,788
Winter Park	980,408	902,827	978,539	975,256	998,772	955,615	990,837	1,077,001	1,007,582	1,000,221
Total Front Range Destination	6,436,409	6,300,408	6,946,740	6,712,778	6,849,814	6,557,301	6,912,651	7,473,578	7,373,588	7,182,456
Gems/Front Range Resorts										
Arapahoe Basin	267,406	220,945	240,406	151,678	317,401	275,428	328,892	326,428	360,247	430,897
Berthoud	20,101	16,870	20,160	DNO	DNO	DNO	DNO	DNO	DNO	DNO
Echo Mountain	DNO	DNO	DNO	DNO	DNO	DNO	DNO	3,238	18,758	23,073
Eldora	175,939	229,785	233,741	250,000	286,528	278,454	281,242	305,030	308,794	286,017
Loveland	230,333	225,896	209,757	199,781	244,621	203,916	240,961	245,610	263,163	280,683
Monarch	140,000	127,215	147,266	138,850	147,094	144,984	142,190	166,451	160,941	175,173
Powderhorn	55,613	71,941	70,118	76,456	79,624	82,948	81,893	79,103	70,714	83,014
Ski Cooper	62,145	60,171	66,225	68,893	64,499	58,408	57,389	64,751	56,669	61,394
SolVista	90,330	92,514	71,303	62,837	65,900	58,482	57,886	64,882	71,633	74,459
Sunlight	78,290	77,047	84,104	82,742	92,382	66,650	72,004	80,139	73,567	78,010
Total Gems/Front Range Destination	1,120,157	1,122,384	1,143,080	1,031,237	1,298,049	1,169,270	1,262,457	1,335,632	1,384,486	1,492,720
Total:	11,389,561	10,892,263	11,666,672	11,128,131	11,605,777	11,250,761	11,816,197	12,533,108	12,566,299	12,540,603
# Increase/Decrease	(590,158)	(497,298)	774,409	(538,541)	477,646	(355,016)	565,436	716,911	33,191	(25,696)
% Increase/Decrease	-4.93%	-4.37%	7.11%	-4.62%	4.29%	-3.06%	5.03%	6.07%	0.26%	-0.20%

Source: Colorado Ski Country USA, http://media-coloradoski.com/cscfacts/skiervisits/

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Colorado Ski Resorts along the I-70 Corridor

Source: TEMS, Inc. and Colorado Ski Country USA.

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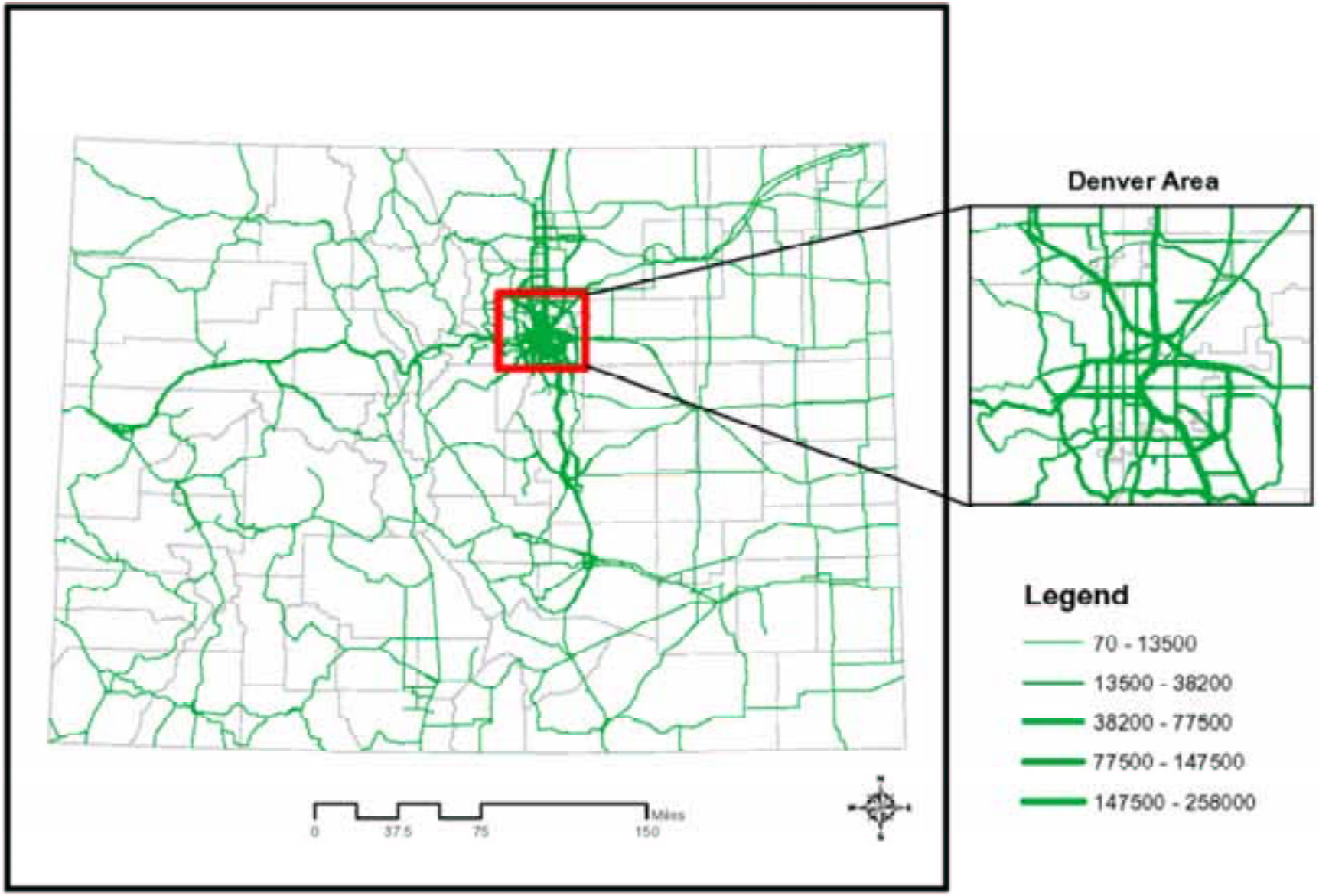
Statewide AADT Counts



Source: CDOT, www.dot.state.co.us/App_DTS_DataAccess/index.ctm

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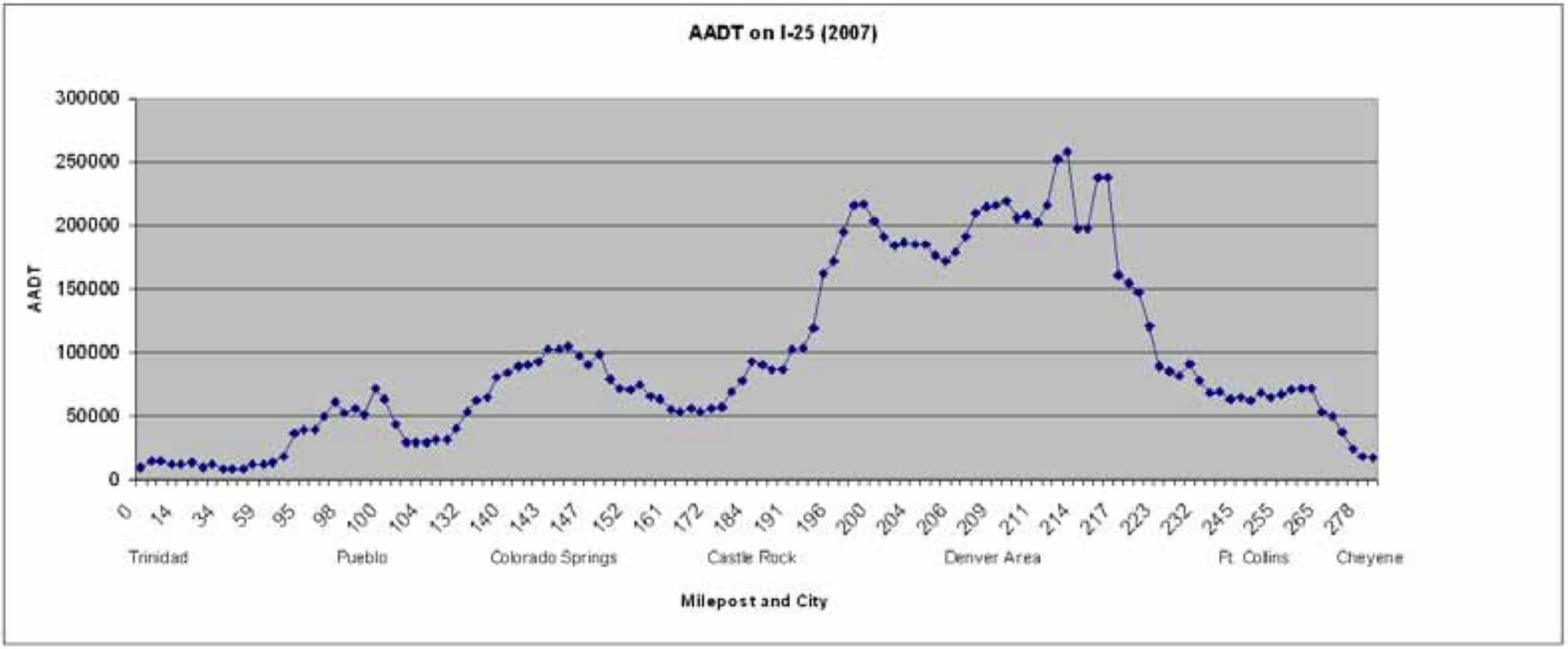
AADT on I-25



Source: CDOT, www.dot.state.co.us/App_DTS_DataAccess/index.ctm

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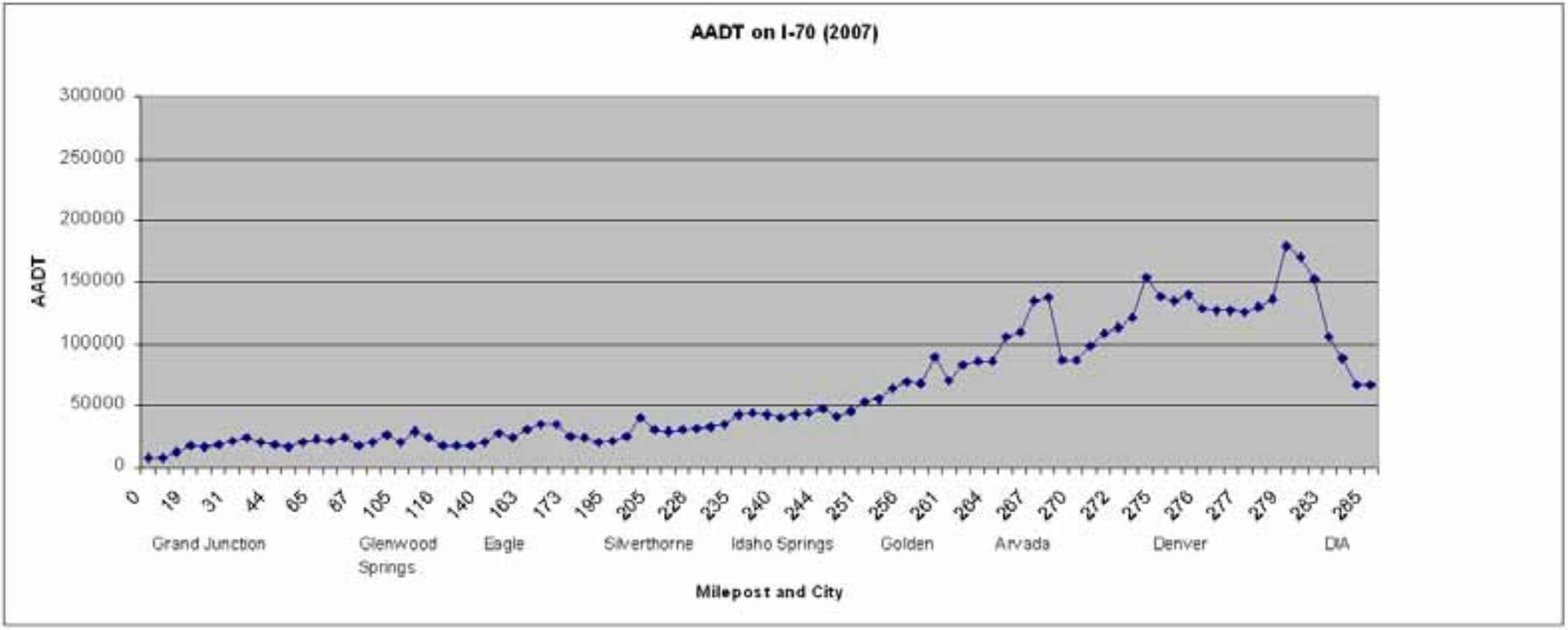
AADT on I-70



Source: CDOT, www.dot.state.co.us/App_DTS_DataAccess/index.ctm

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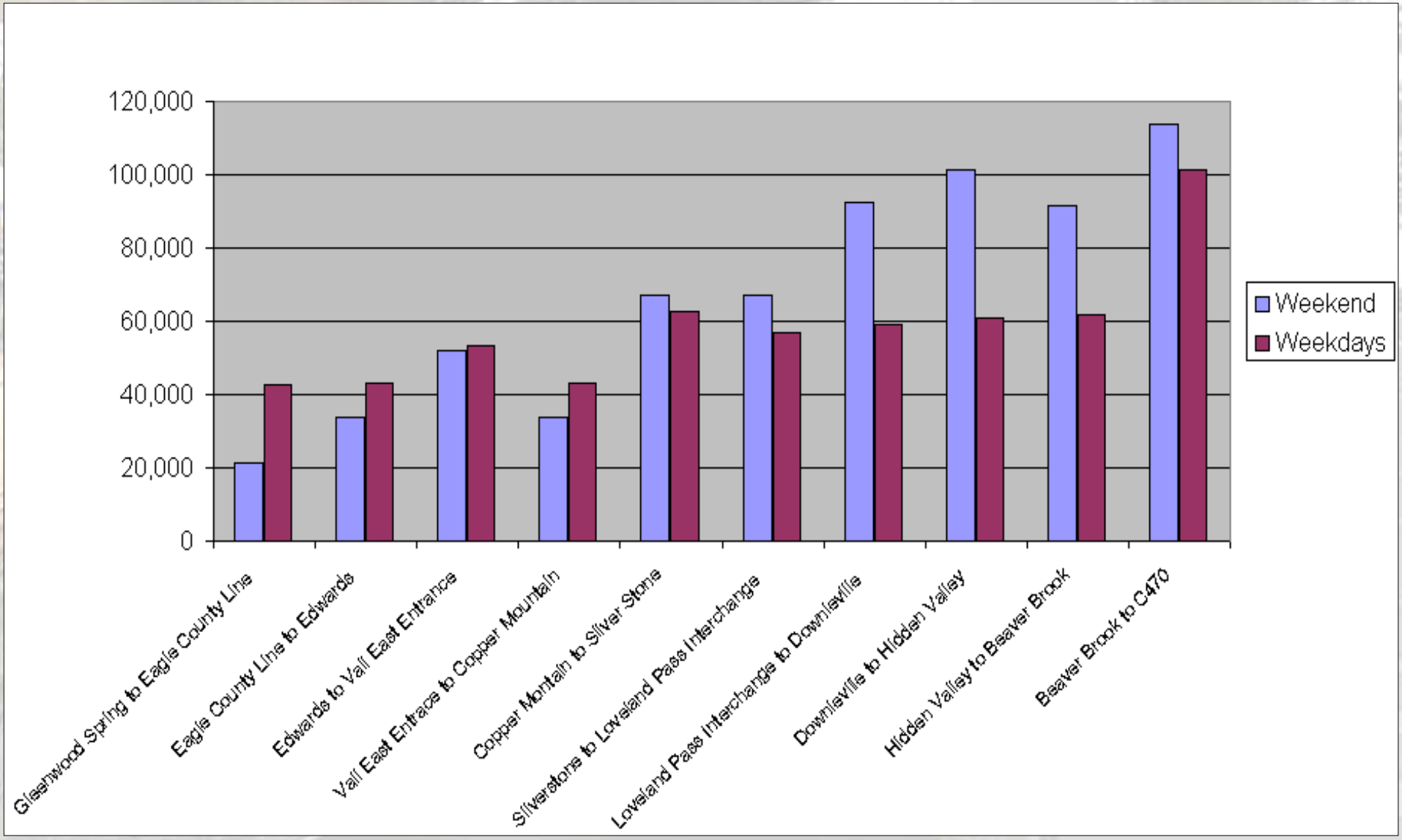
I-70 Corridor Weekday and Weekend Daily Vehicle Trips



Source: I-70 PEIS

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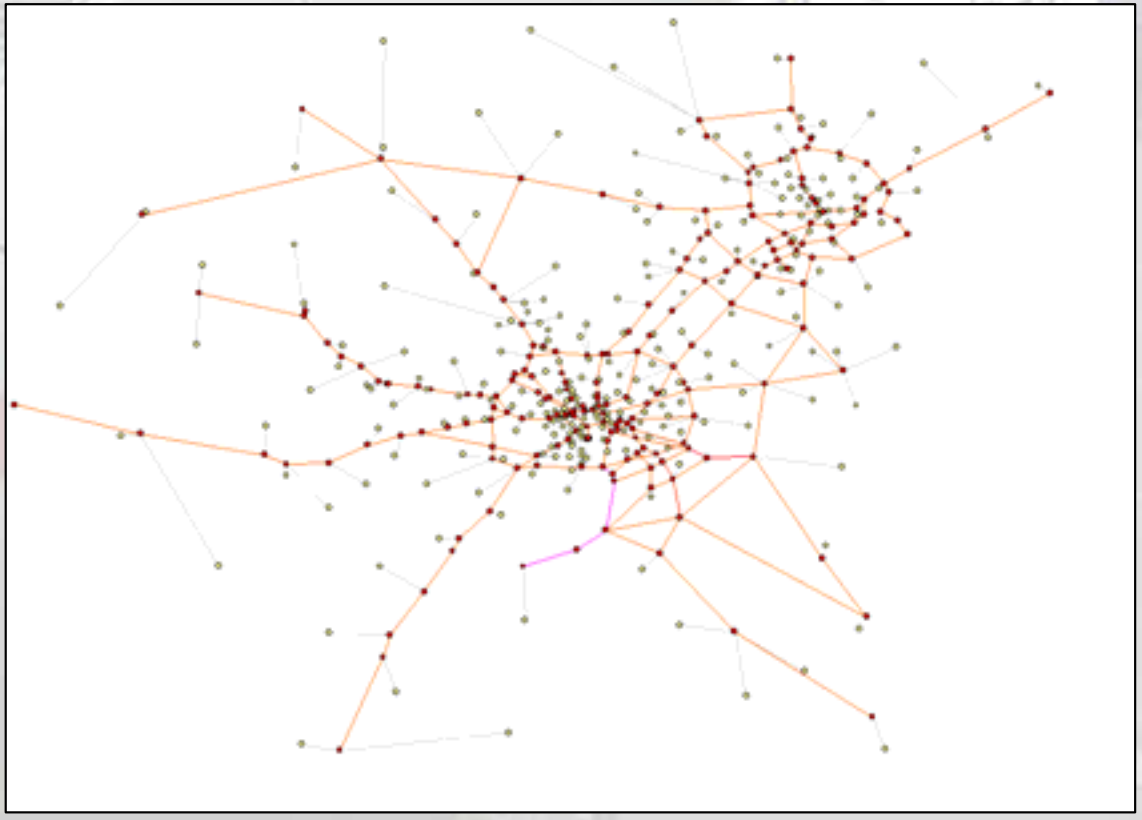
Networks

- **Networks will be developed for four modes and four purposes:**
  - Auto
  - Bus
  - Air Access
  - Rail
  - Business
  - Commuter
  - Social
  - Tourist

Example Highway Network



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Generalized Cost Components

	Public Modes	Auto
Time	In-vehicle Time Access/Egress Time Number of Interchanges Connection Wait Times Terminal Wait Times	Travel Time
Costs	Fare Access/Egress Costs	Operating Costs Tolls Parking (all divided by occupancy)
Reliability	On Time Performance	
Schedule	Frequency of Service Convenience of Times	

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VOT and VOF are needed to define Travel Utility Equation for the Networks

$$U_{ijp} = f(GCijp)$$

Where

GC_{ijp} = Generalized cost of travel between zones i and j for purpose p

$$GC_{ijmp} = TT_{ijm} + \frac{TC_{ijmp}}{VOT_{mp}} + \frac{VOF_{mp} \times OH}{VOT_{mp} \times F_{ijm}}$$

Where

TT_{ijm} + = Travel time between zones i and j for mode m (in-vehicle time + waiting time delay time + connect time + access/egress time + interchange penalty), with waiting, delay, connect and access/egress time multiplied by two to account for the additional disutility felt by travelers for these activities

TC_{ijmp} = Travel cost between zones i and j for mode m and purpose p (fare + access/egress cost for public modes, operating costs for auto)

VOT_{mp} = Value of Time for mode m and purpose p

VOF_{mp} = Value of Frequency for mode m and purpose p

F_{ijm} = Frequency in departures per week between zones i and j for mode m

OH = Operating hours per week

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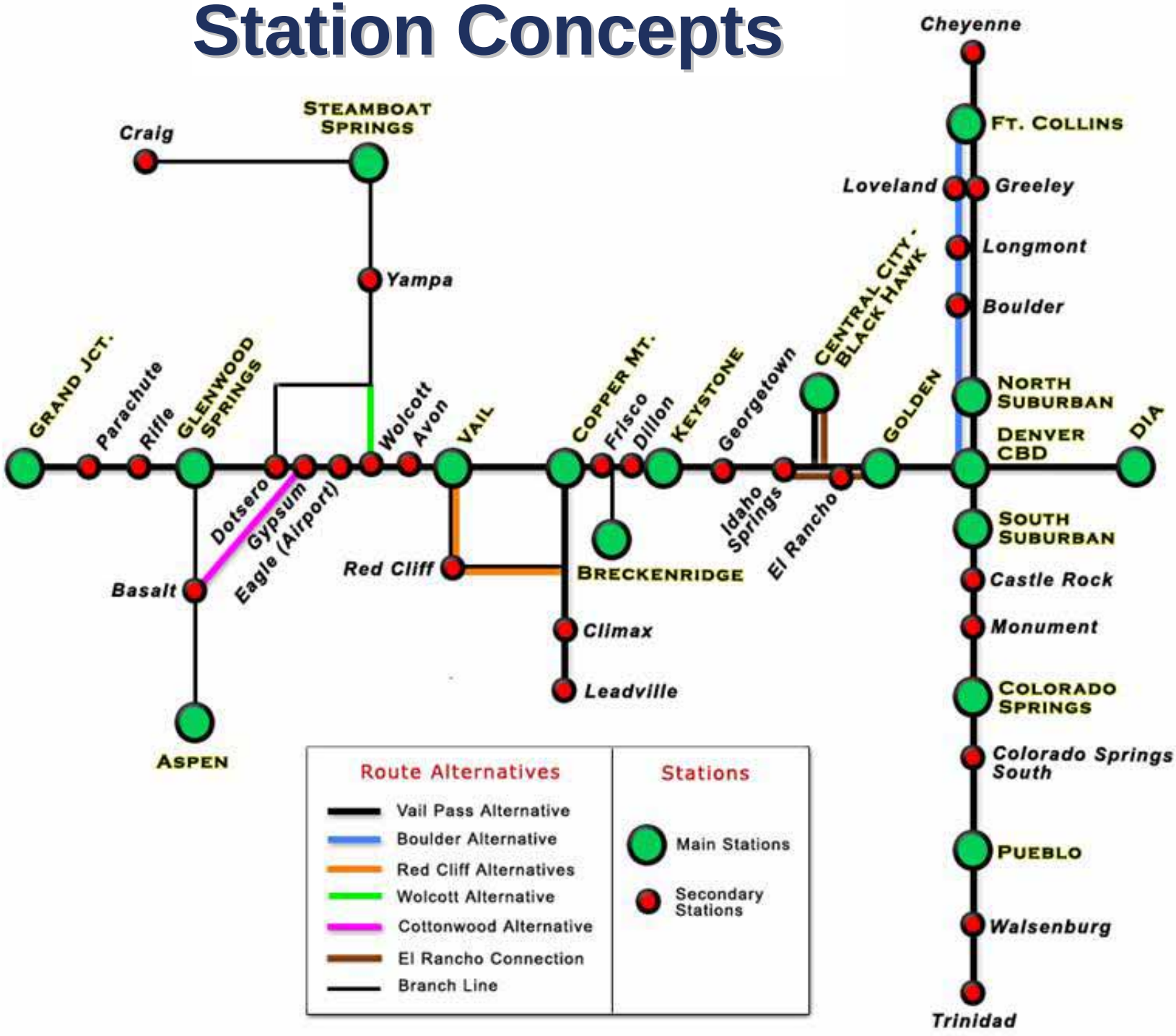
Station Concepts



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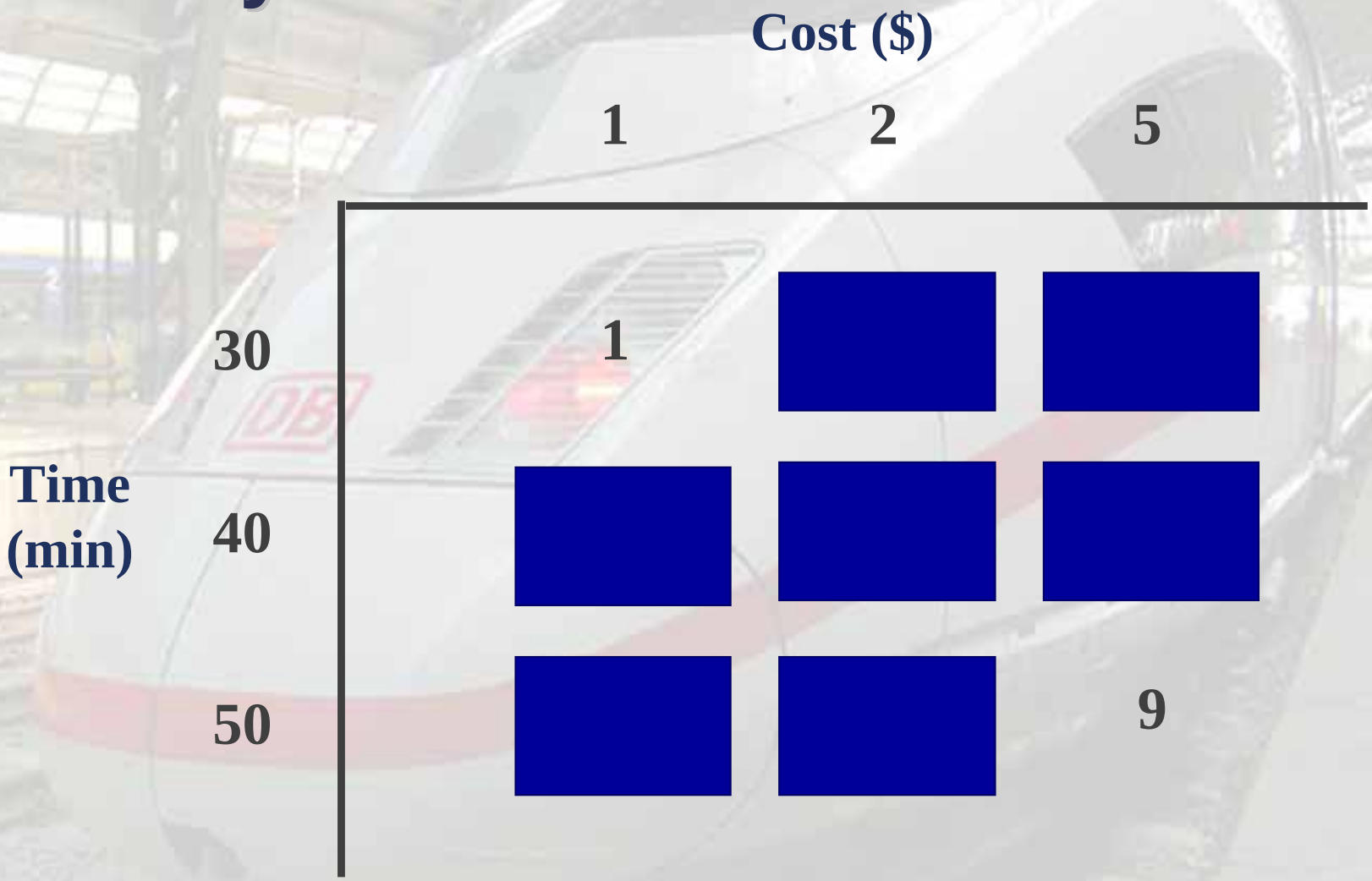
We will carry out a Stated Preference Survey



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Survey Background

- **Goals**
  - Quantify how much travelers value time and frequency.
  - Discriminate behavior by mode and purpose of travel.
  - Evaluate O/D flows.
- **Approach**
  - Quota Surveys with individual "Sample Frame" Targets by Sub-Group (e.g. Trip Length, Mode, Trip Purpose).
- **Survey Implementation**
  - Pilots "test the waters" before full deployment of the Survey Team.
  - Fall Survey (completed) was targeted Primarily at Colorado Resident and non-seasonal tourism.
  - Winter Survey (future) will primarily focus on the Resort tourism and employee trip-making, but it will also provide a 2nd opportunity to adjust Resident survey counts as needed to fulfill specific "Sample Frame" Targets.

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Proposed Survey Objectives

Location	Fall	Winter
Denver Int'l Airport	✖	✖
Buses (RTD/FREX/Greyhound)	✖	
Resorts*		✖
Amtrak	✖	
Ski Train		✖
DMV	✖	

*** Resorts dropped from the Fall Survey due to low activity.**

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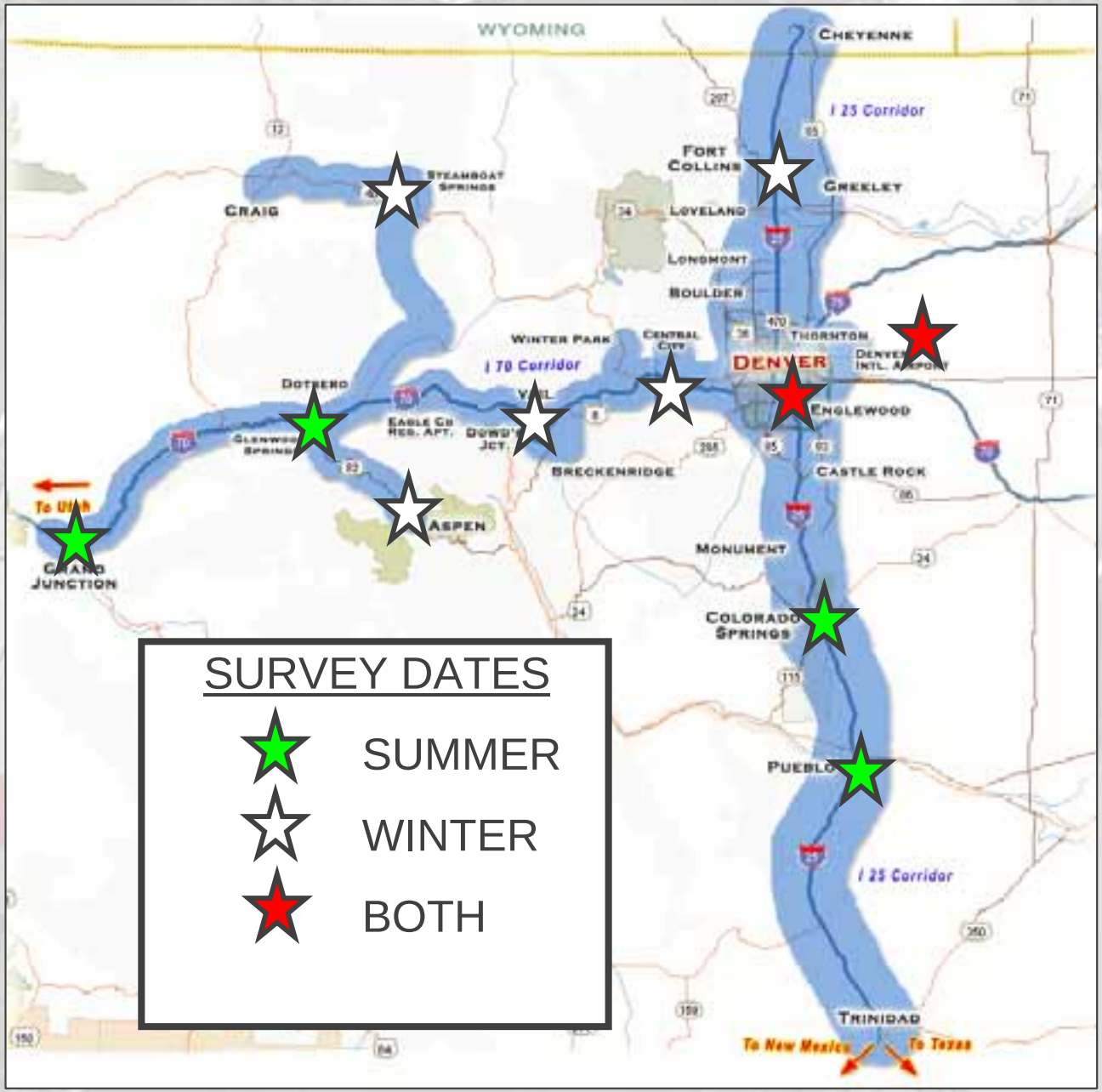
Survey Locations and Dates



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Pilot Results*

- **Basic survey design was validated.**
  - Stated preference questions were scaled so that respondents did "trade" within the ranges provided by the survey forms.
  - Minor adjustments to wording of questions and format were made to improve the readability of the forms.
  - The surveys were kept to one-page, one-side only.
- **Direct interview approach.**
  - All interviewees screened to see if they have enough time to complete the survey.
  - At DIA airport, connecting flights were screened out.
  - Most interviewees filled out the form themselves in 2-3 minutes.
- **Additional survey locations were added to the original plan.**
  - Pueblo and Grand Junction DMV's.
  - FREX bus surveys were shifted to Colorado Springs, Monument and Castle Rock.
  - Greyhound at Denver.
  - Amtrak at Grand Junction.

*** Pilots were conducted September 26 through October 1, 2008**

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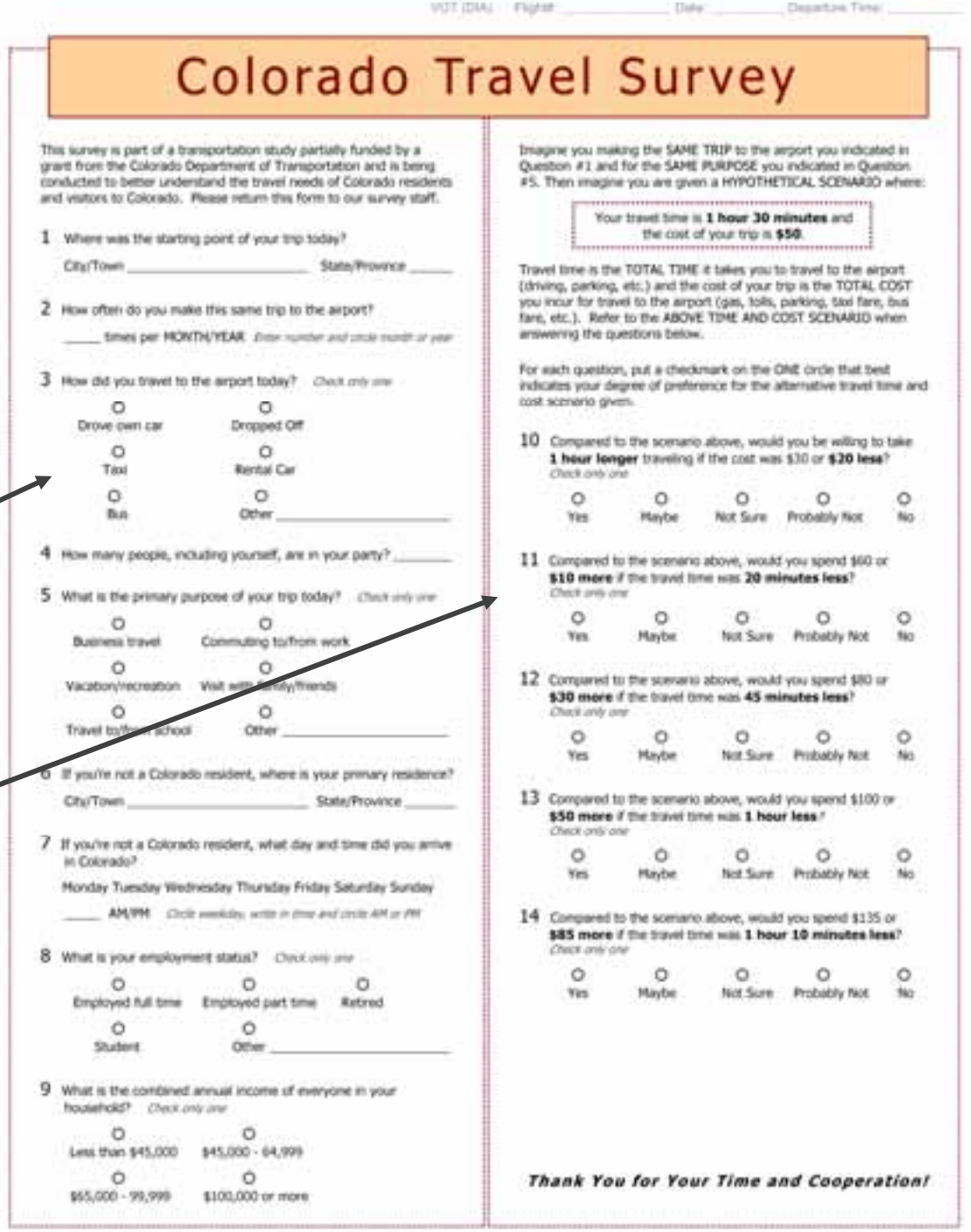
Example DIA Survey Questionnaire

Classification Questions on Left

Value of Time (VOT) Questions on Right*



VOT (DIA) Flight# _____ Date _____ Departure Time _____

Colorado Travel Survey

This survey is part of a transportation study partially funded by a grant from the Colorado Department of Transportation and is being conducted to better understand the travel needs of Colorado residents and visitors to Colorado. Please return this form to our survey staff.

1 Where was the starting point of your trip today?

City/Town _____ State/Province _____

2 How often do you make this same trip to the airport?

_____ times per MONTH/YEAR *Enter number and circle month or year*

3 How did you travel to the airport today? *Check only one*

○ Drove own car ○ Dropped Off
○ Taxi ○ Rental Car
○ Bus ○ Other _____

4 How many people, including yourself, are in your party? _____

5 What is the primary purpose of your trip today? *Check only one*

○ Business travel ○ Commuting to/from work
○ Vacation/recreation ○ Visit with family/friends
○ Travel to/from school ○ Other _____

6 If you're not a Colorado resident, where is your primary residence?

City/Town _____ State/Province _____

7 If you're not a Colorado resident, what day and time did you arrive in Colorado?

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

_____ AM/PM *Circle weekday, write in time and circle AM or PM*

8 What is your employment status? *Check only one*

○ Employed full time ○ Employed part time ○ Retired
○ Student ○ Other _____

9 What is the combined annual income of everyone in your household? *Check only one*

○ Less than $45,000 ○ $45,000 - 64,999
○ $65,000 - 99,999 ○ $100,000 or more

Imagine you making the SAME TRIP to the airport you indicated in Question #1 and for the SAME PURPOSE you indicated in Question #5. Then imagine you are given a HYPOTHETICAL SCENARIO where:

Your travel time is **1 hour 30 minutes** and the cost of your trip is **$50**.

Travel time is the TOTAL TIME it takes you to travel to the airport (driving, parking, etc.) and the cost of your trip is the TOTAL COST you incur for travel to the airport (gas, tolls, parking, taxi fare, bus fare, etc.). Refer to the ABOVE TIME AND COST SCENARIO when answering the questions below.

For each question, put a checkmark on the ONE circle that best indicates your degree of preference for the alternative travel time and cost scenario given.

10 Compared to the scenario above, would you be willing to take **1 hour longer** traveling if the cost was $30 or **$20 less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

11 Compared to the scenario above, would you spend $60 or **$10 more** if the travel time was **20 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

12 Compared to the scenario above, would you spend $80 or **$30 more** if the travel time was **45 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

13 Compared to the scenario above, would you spend $100 or **$50 more** if the travel time was **1 hour less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

14 Compared to the scenario above, would you spend $135 or **$85 more** if the travel time was **1 hour 10 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

Thank You for Your Time and Cooperation!

***The Bus and Rail Surveys also include a Value of Frequency (VOF) Question**

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Stated Preference Sample Frame

Target Survey Goals by Sub-Market Category

	Business		Commuter		Social		Tourist	
	S	L	S	L	S	L	S	L
Rail	0	0	0	0	0	80	80	80
Air	0	80	0	80	0	80	0	80
Bus	0	80	80	80	80	80	0	80
Auto	80	80	80	80	80	80	80	80

S = Short Distance

L = Long Distance

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Stated Preference Sample Frame and Results

Target (Fall + Winter) / Actual Results (Fall Only)

	Business	Commuter	Social	Tourist
Rail	0 / 8	0 / 2	80 / 68	160 / 140
Air Access	80 / 336	80 / 13	80 / 395	80 / 358
Bus	80 / 45	160 / 172	160 / 117	80 / 44
Auto	160 / 236	160 / 163	80 / 456	160 / 235

- The Winter survey deployment plan will be established as necessary to fulfill quotas for each sub-grouping
- Office Count Excludes Unusable Surveys

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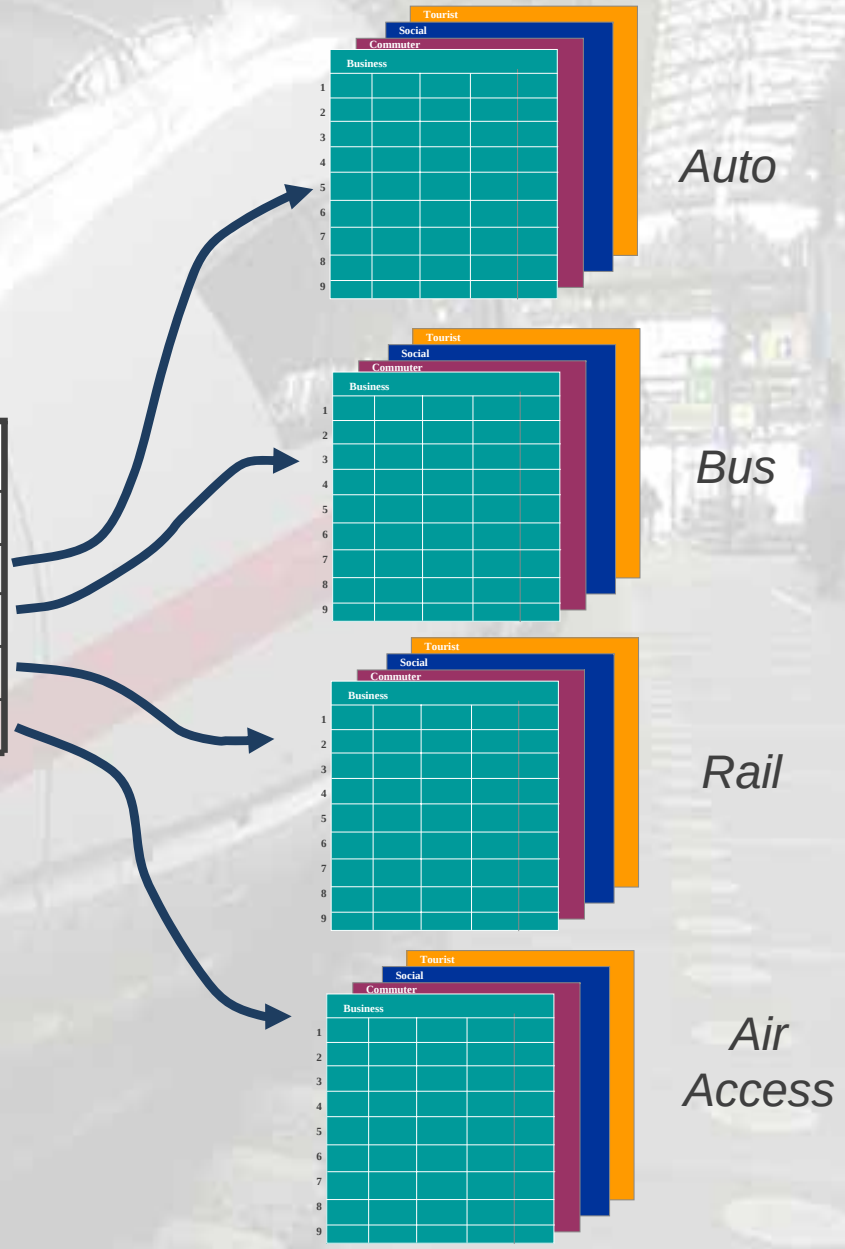
Differential VOT Scaled to OD Matrices

VOT MATRIX

	Trip Purpose			
Mode	Business	Commuter	Social	Tourist
Auto	$x.xx	$x.xx	$x.xx	$x.xx
Bus	$x.xx	$x.xx	$x.xx	$x.xx
Rail	$x.xx	$x.xx	$x.xx	$x.xx
Air Access	$x.xx	$x.xx	$x.xx	$x.xx



Different VOT's are Applied to each Matrix depending on Mode and Trip Purpose

Total OD Travel Volumes are used to scale Quota Groups to the total population size

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Fall Survey Actual Deployment

Fall Survey Team Actual Deployment

	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun
	2-Oct	3-Oct	4-Oct	5-Oct	6-Oct	7-Oct	8-Oct	9-Oct	10-Oct	11-Oct	12-Oct
DIA Airport Survey											
Colorado Springs DMV and FREX Bus											
Pueblo DMV											
Glenwood Springs DMV and Amtrak											
Grand Junction DMV and Amtrak											
Denver DMV, Greyhound, Amtrak and RTD Bus											
Denver Amtrak, Greyhound and RTD Bus											

Fall Survey Team Targets v. Actuals

Location	Survey Goal	Field Count
DIA Airport	1,000	1,105
Amtrak	200	220
RTD Regional Bus	250	209
FREX Bus	100	73
Greyhound Bus	0	99
DMV	1,000	1,102
TOTAL	**2,550**	**2,808**

Overall Bus Surveys:

350 Target v. 381 Actual

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Total Demand Model

$$T_{ijp} = e^{B0p}(SE_{ijp})^{B1p}(U_{jp})^{B2p}$$

Where

T_{ijp}= Volume of trips between zones i and j for purpose p

Se_{ijp}= Socioeconomic variables for zones i and j for purpose p

U_{ijp}= All mode generalized cost of travel for zones I and j for purpose p

B_{0p}, B_{1p}, B_{2p} = Calibration parameters for purpose p

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Travel Utility

$$U_{ijp} = f(GC_{ijp})$$

Where

GC_{ijp} = Generalized cost of travel between zones i and j for purpose p

$$GC_{ijmp} = TT_{ijm} + \frac{TC_{ijmp}}{VOT_{mp}} + \frac{VOF_{mp} \times OH}{VOT_{mp} \times F_{ijm}}$$

Where

TT_{ijm} = Travel time between zones i and j for mode m (in-vehicle time + waiting time + delay time + connect time + access/egress time + interchange penalty), with waiting, delay, connect and access/egress time multiplied by two to account for the additional disutility felt by travelers for these activities

TC_{ijmp} = Travel cost between zones i and j for mode m and purpose p (fare + access/egress cost for public modes, operating costs for auto)

VOT_{mp} = Value of Time for mode m and purpose p

VOF_{mp} = Value of Frequency for mode m and purpose p

F_{ijm} = Frequency in departures per week between zones i and j for mode m

OH = Operating hours per week

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Modal Split Hierarchical Structure

- **Only two choices exist at each level of the modal split hierarchical structure, a Binary Logit Model is used, as shown in Equation 1:**

Equation 1:

$$P_{ijmp} = \frac{\exp(U_{ijmp}/\rho)}{\exp(U_{ijmp}/\rho) + \exp(U_{ijnp}/\rho)}$$

Where,

P_{ijmp} = Percentage of trips between zones *i* and *j* by mode *m* for trip purpose *p*

- U_{ijmp}, U_{ijnp} = Utility functions of modes *m* and *n* between zones *i* and *j* for trip purpose iρ is called the nesting coefficient

- **In Equation 1, the utility of travel between zones i and j by mode m for trip purpose p is a function of the generalized cost of travel. Where mode m is a composite mode (e.g., the surface modes in the third level of the Modal Split Model hierarchy, which consist of the rail and bus modes), the utility of travel, as described below, is derived from the utility of the two or more modes it represents.**

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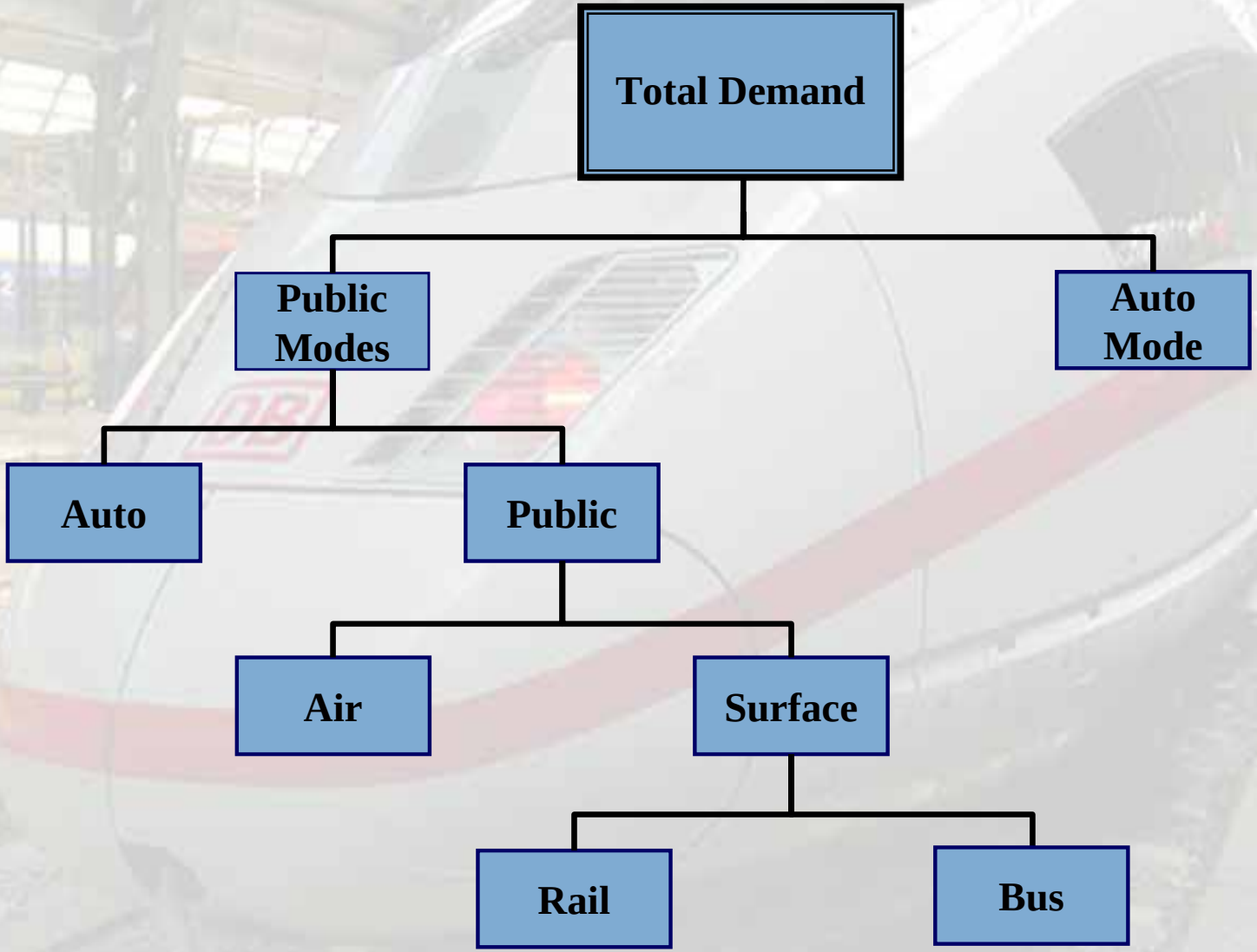
Modal Split Structure



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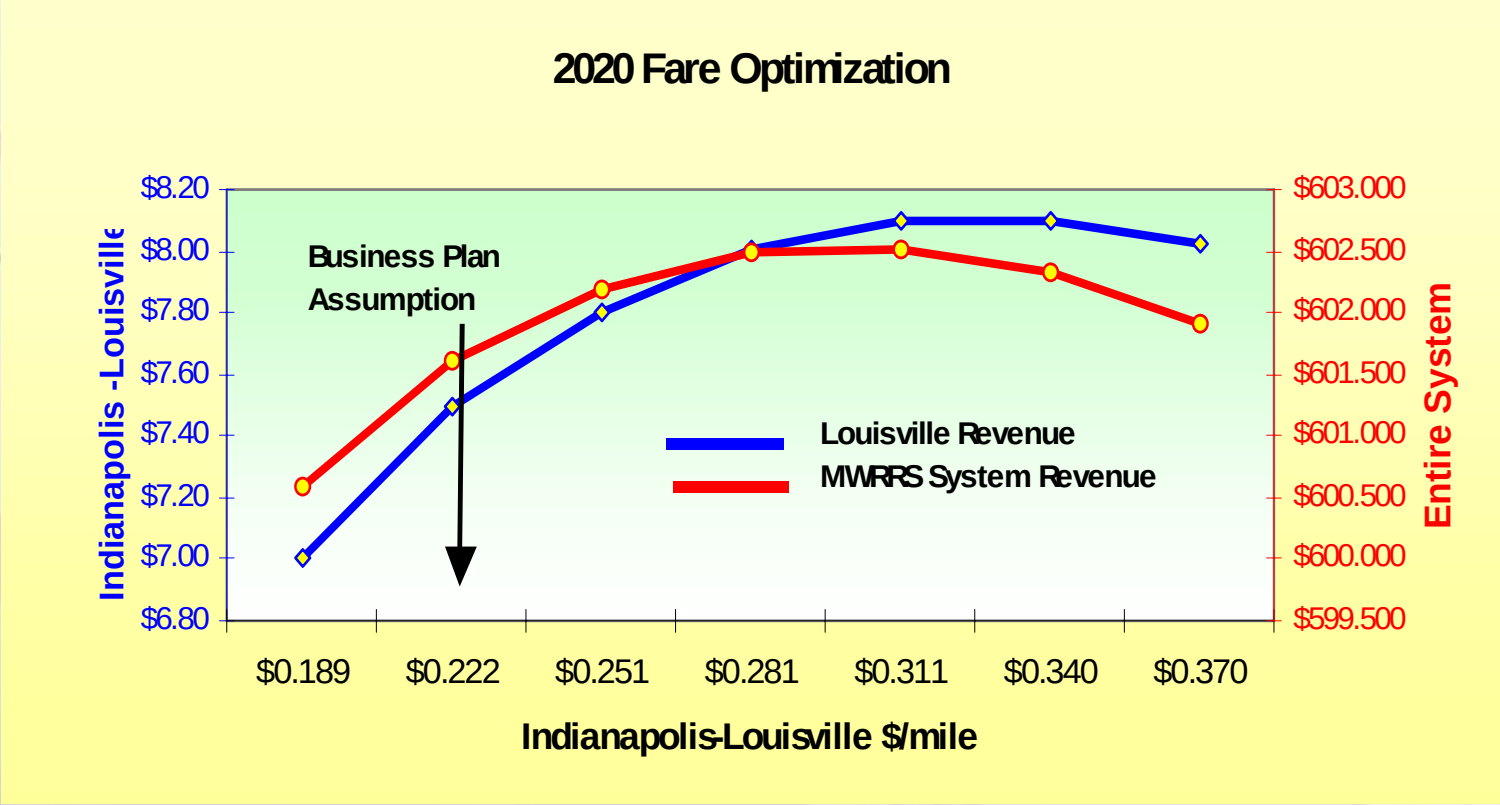
Revenue Yield Analysis

- Revenue optimization by:
  - Corridor and market segment
  - City pair
  - Time of day



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Thank You

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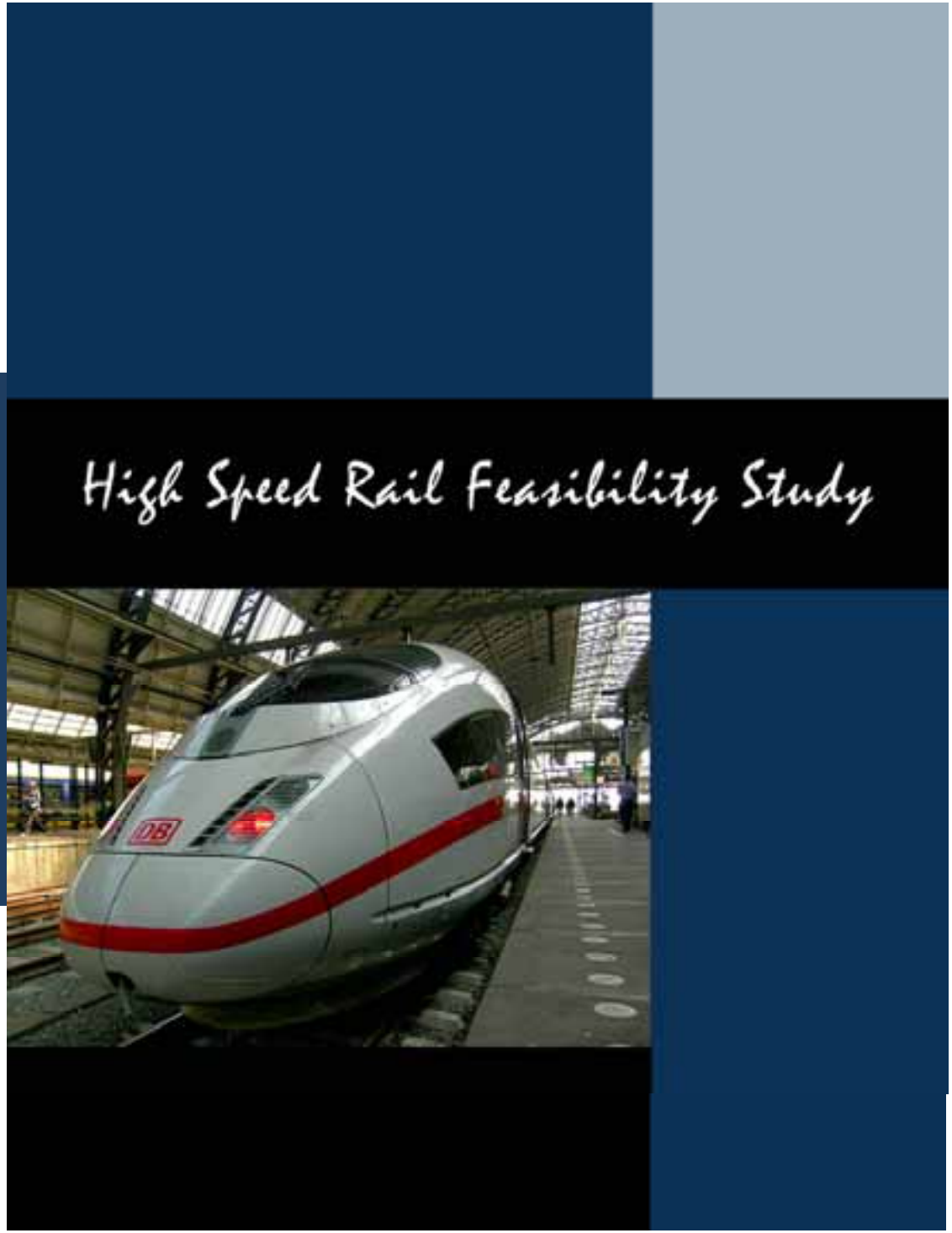
APPENDIX D: ALTERNATIVE TECHNOLOGIES PRESENTATION

Presentation To

RMRA Peer Panel Workshop – Day #1

Technology Options

November 19, 2008



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Presentation Outline

- **Structure of Assessment**
  - Technology categories
- **Regulatory and Methodology Review**
  - FRA regulations
  - Technology performance parameters
    - Alignment speed evaluation approach
    - Rail Technology Variants
    - Maglev Technology Variants
    - Approach to Novel Technology Evaluation
- **Representative Technologies**
  - Criteria for Selection of “Generic Train”
  - Rail and maglev options

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Structure of Assessment

Technologies will be Clustered, based on speed capability, into the following five Categories:

	79-mph	110-130 mph	150-220 mph	250-300 mph
Rail	X	X	X	
Maglev		X		X

Within each category the performance capabilities of the vehicles will be very similar. The objective is to develop a representative “Generic Train” specification that characterizes the technology for the purpose of evaluation.

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Regulatory and Methodology Review

FRA Safety Regulations

- **FRA Regulations define basic safety rules for window glazing, interior lighting, baggage securement, etc.**
  - **These apply to all equipment, steel wheel and maglev, regardless of track sharing.**
- **Tier I and Tier II crashworthiness standards.**
  - **For Steel Wheel equipment that operates on the US national freight and passenger rail system.**
    - FRA Requires Tier I/II for sharing tracks.
    - Class I Railroads are increasingly requiring it just to share ROW and not tracks (e.g. RTD).
    - Tier I/II not required for vehicles that do not share track or ROW with freight rail.
  - **Technical Requirements:**
    - Buff strength requirement for passenger cars of 800,000# is the same for both tier I and tier II passenger cars.
    - Tier II locomotives need 2,100,000# buff strength.
    - Tier II equipment must be designed for “crash energy management.”
    - Leading unit may not be occupied by passengers in Tier II equipment.

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Technology Assessment Process

- **The steel-wheel technology assessment includes both "Compliant" and "Non Compliant" equipment types.**
  - Our evaluation indicates that "Non Compliant" steel-wheel equipment could generally be made "Compliant" to US Standards for about 10% weight penalty over comparable European practice.
  - Within this range it is generally possible to compensate the effect of small added weight by adding power to maintain train performance. With this caveat, the European train performance curves still remain applicable.
- **The technology assessment includes a range of Maglev equipment types and technologies.**
  - Only the Transrapid system is in commercial High Speed operation today.
  - HSST Maglev is in commercial Low Speed operation today. Conceptually similar systems have been developed by both American Maglev and General Atomics and are on test tracks.
  - We will evaluate Low Speed maglev based on the system parameters that were developed by the 2004 Colorado Maglev Study. It has been estimated that a $400-600 Million R&D effort (in $2003) will be required to realize these parameters in practice.

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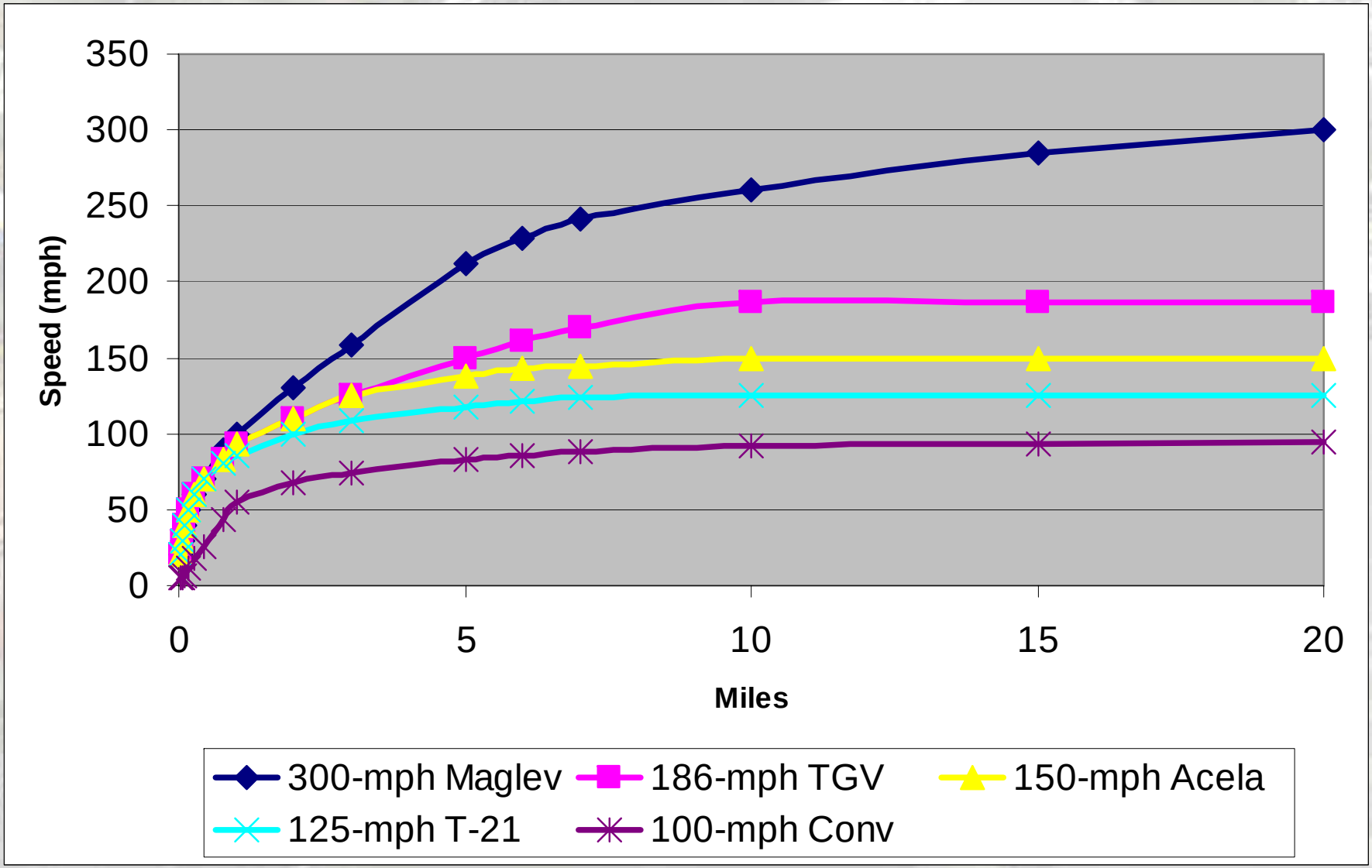
Maglev and Steel-Wheel Performance

(Straight and Level Track)



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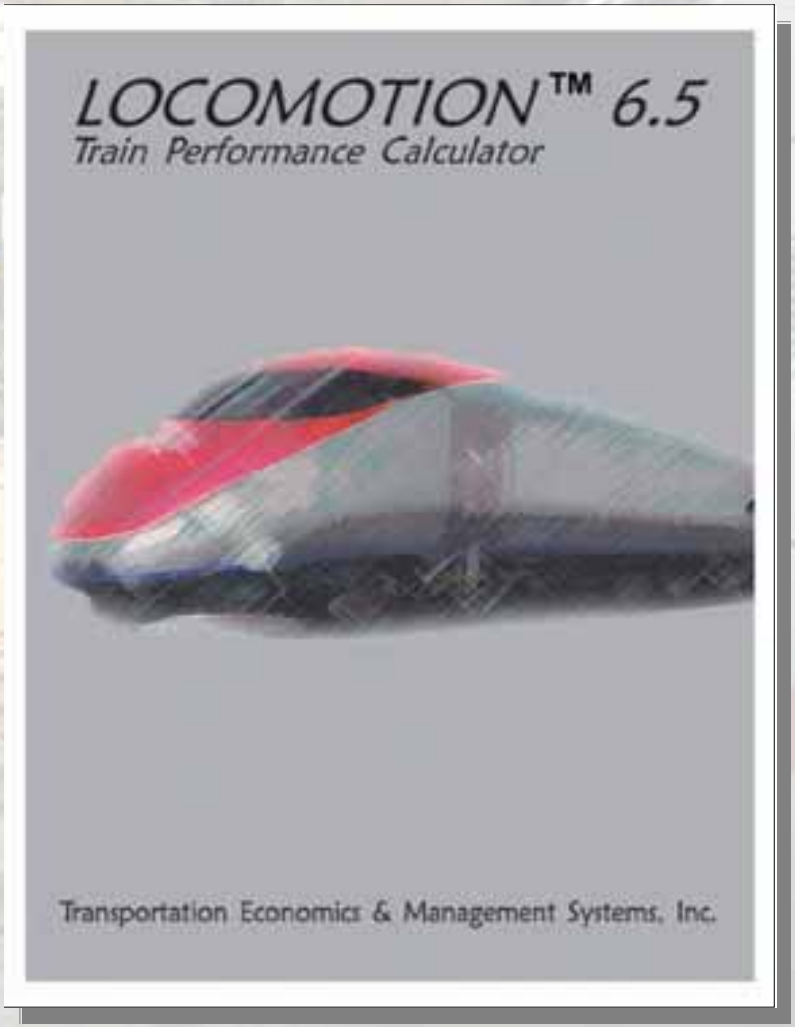
LOCOMOTION™ will estimate Train Speeds and Timetables



- **LOCOMOTION™** generates optimized timetables for given track infrastructure, signaling systems, and train technologies. It provides milepost-by-milepost graphic output of train performance based on track characteristics and shows the effect on timetables for improving the track, using a different technology.
- Because **LOCOMOTION™** takes account of other passenger and freight traffic using a right-of-way, it can develop stringline diagrams and identify the optimum train path for a new service.

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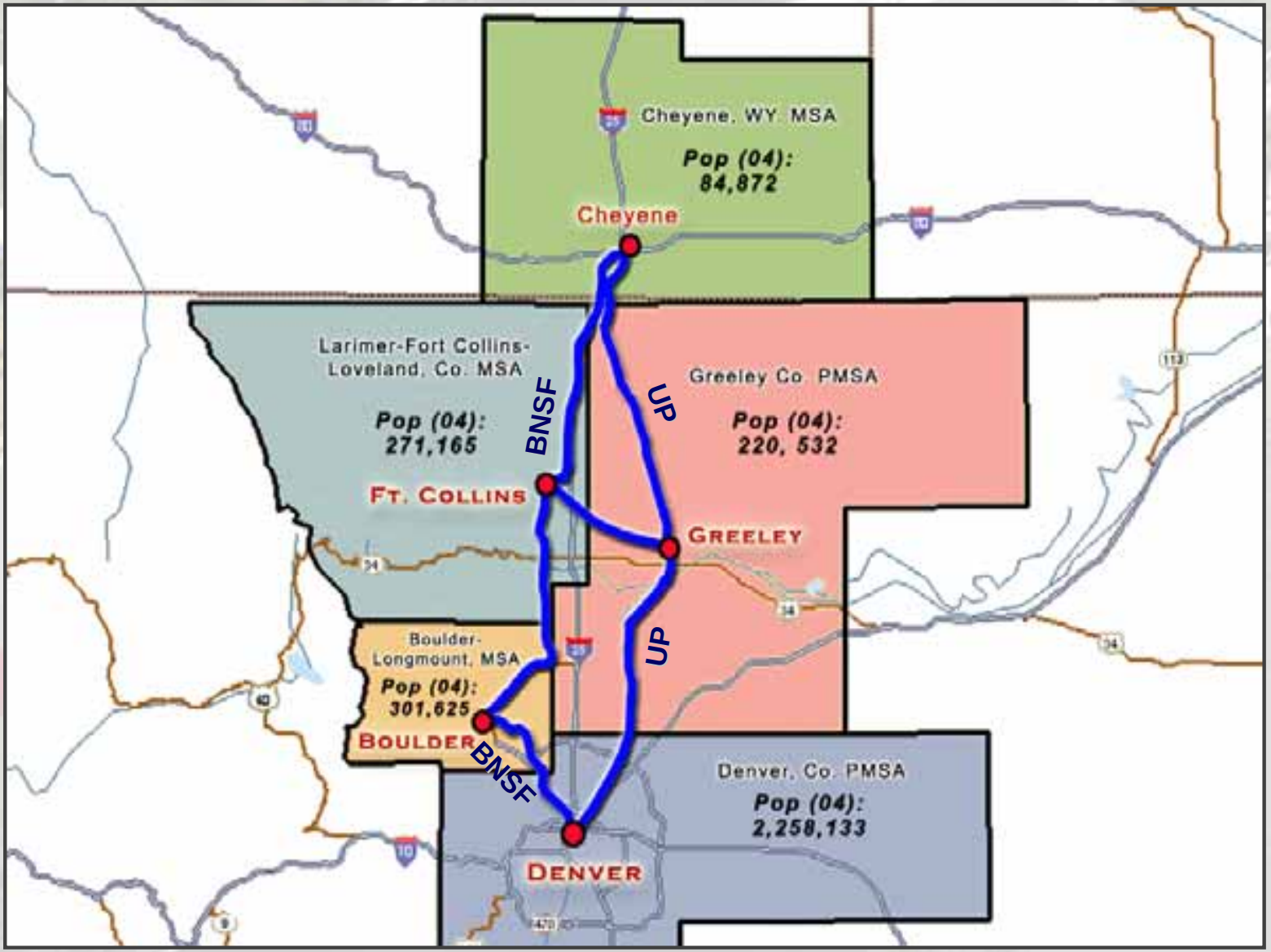
Case Study:
UP vs. BNSF Northern Options



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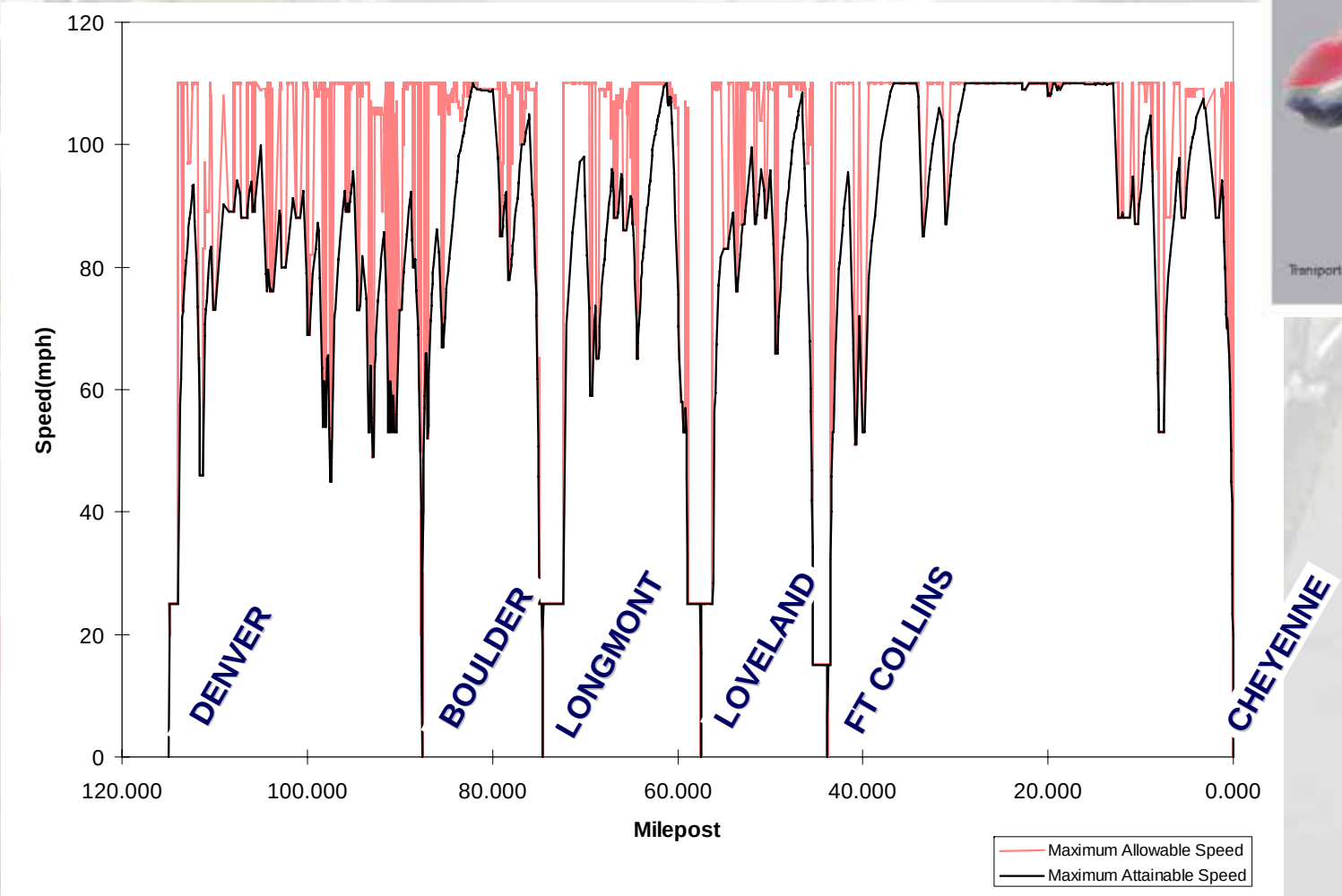
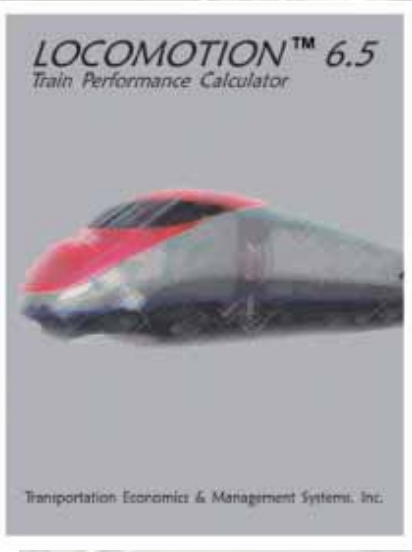
Train Performance Evaluation
("First Cut" and Preliminary)

Speed Profile – BNSF Line
115 miles – 1:48 Running Time





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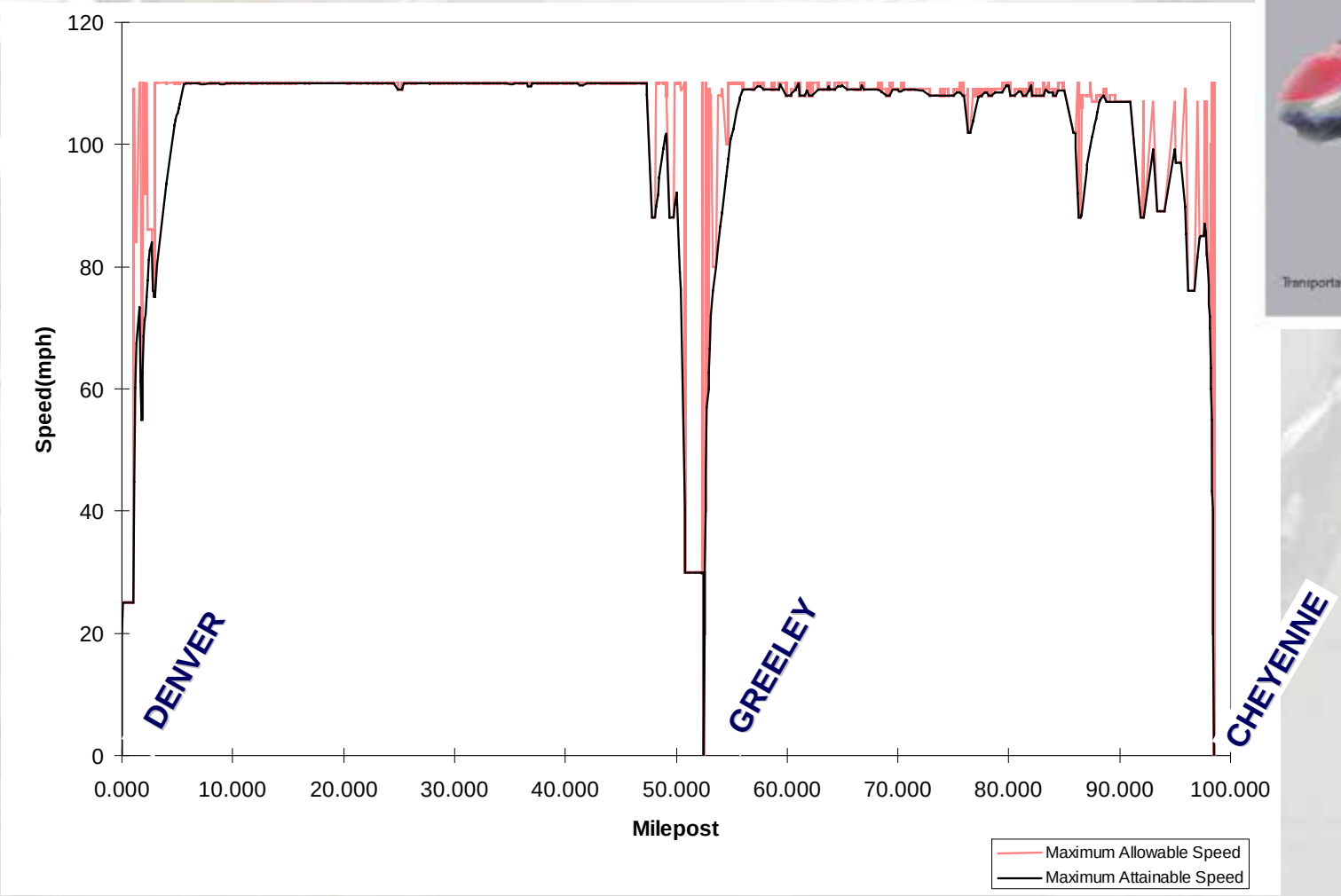
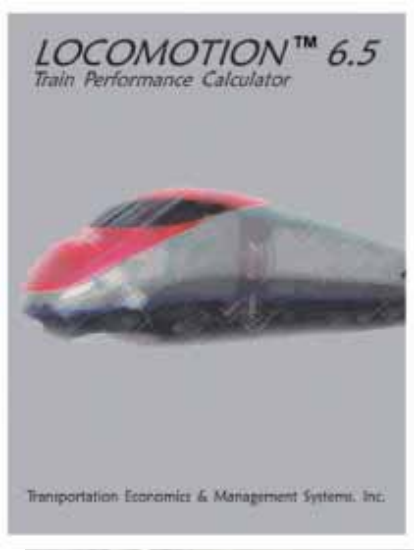
Train Performance Evaluation
("First Cut" and Preliminary)

Speed Profile – UP Line
98 miles – 1:05 Running Time





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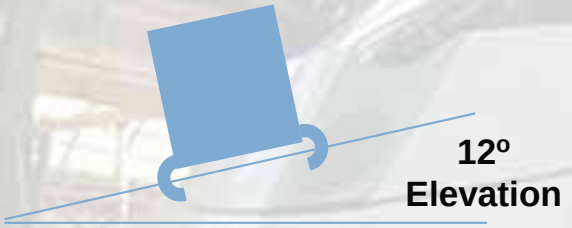
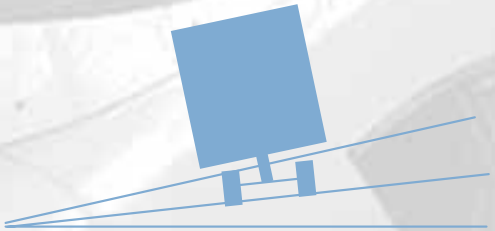
Rail and Maglev Curving Capabilities

MAGLEV



TILT TRAIN



Banking Capabilities

- Maglev and Rail tilt train banking capabilities are both approximately12º within FRA guidelines, practically equivalent to one another.
- Will lead to essentially the same speed restrictions through curves.
- Maglev and Rail tilt trains will both be faster (20-30%) than equivalent non-tilting trains.

Calculation of Degrees Curvature

Degree	Radius
1	5,730 feet
2	2,865 feet
3	1,910 feet
4	1,433 feet
5	1,146 feet
6	955 feet

Maglev or Tilt Train Speed through Curves

		Passenger Reference Speeds (mph) with 6.0" Deficiency					
		Degree of Curve					
		1	2	3	4	5	6
Superelevation (in.)	0	93	65	53	46	41	38
	1	100	71	58	50	45	41
	1.5	104	73	60	52	46	42
	2	107	76	62	53	48	44
	3	113	80	65	57	51	46
	4	120	85	69	60	53	49
	5	125	89	72	63	56	51
	6	131	93	76	65	59	53

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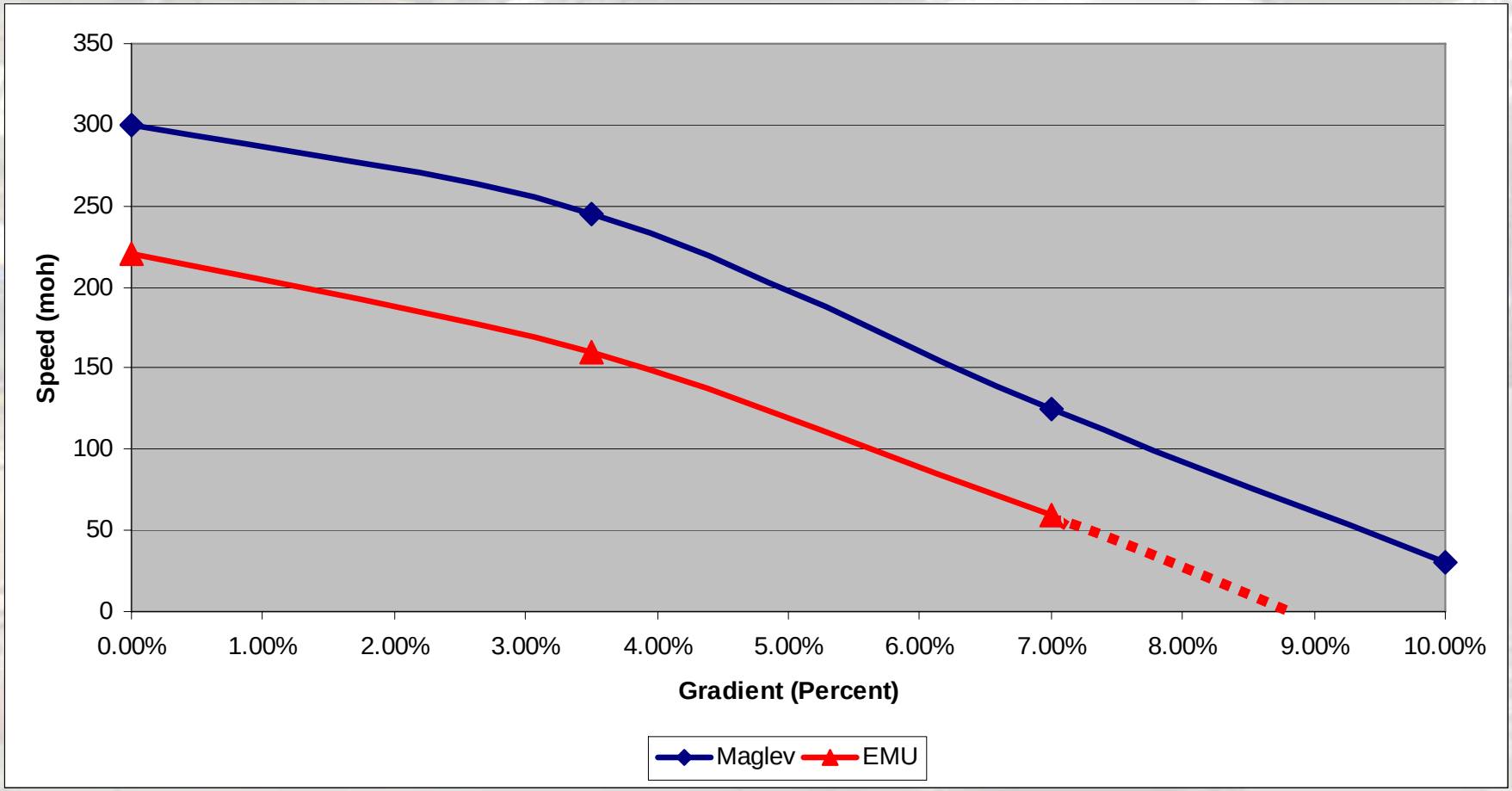
Rail and Maglev Gradient Capabilities



Source: http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/maglev/Chap1+2(p1_16).pdf

- **Maglev is going up 7% grade at 125-mph**
- **EMU is going up a 7% grade at 60-mph**

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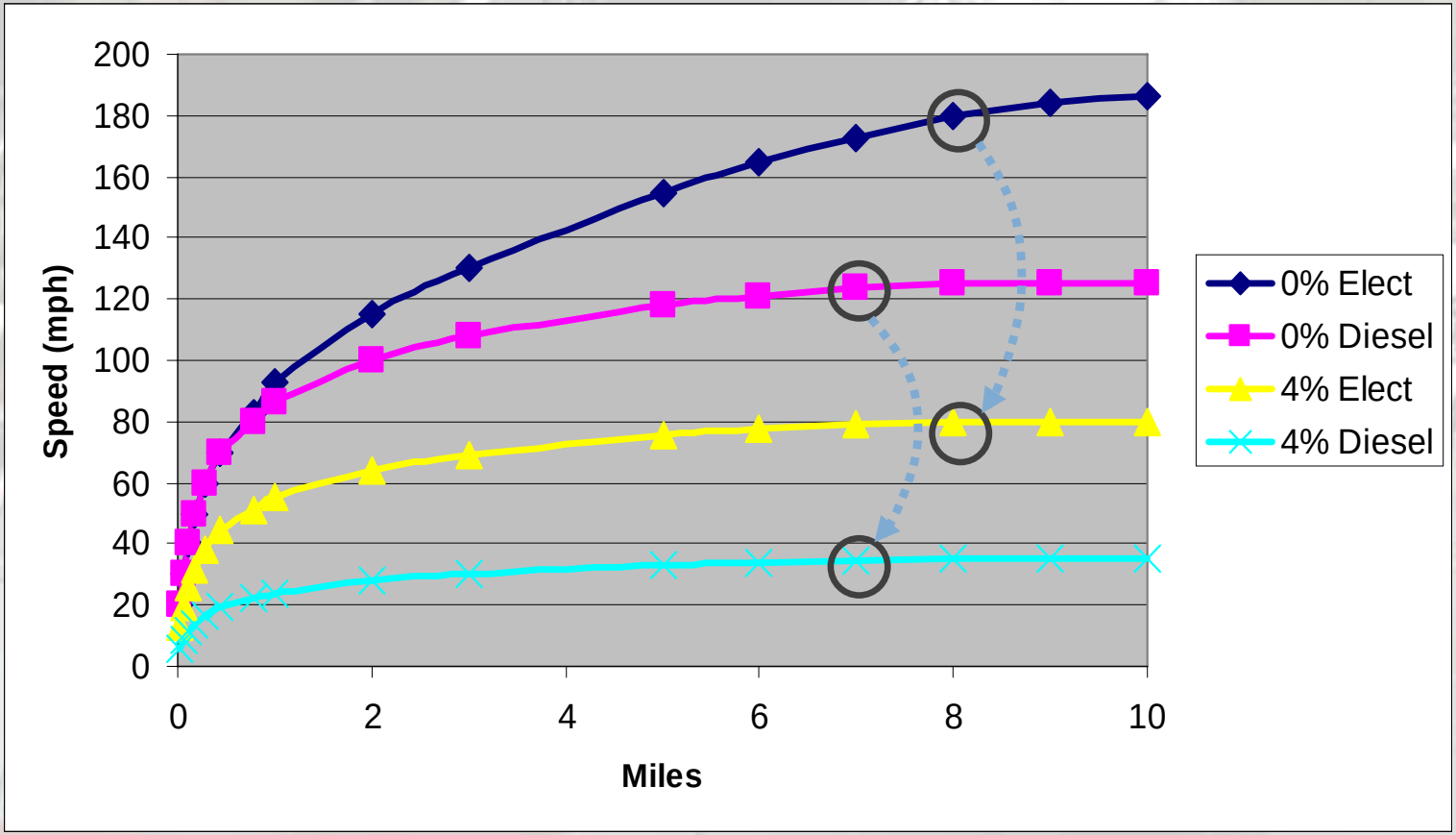
Rail Technology Issues – Power Source



Train Acceleration On Straight-and-Level Track versus 4% Uphill Grade.
Electric Trains Max Speed 186-mph; Diesel 125-mph

Diesel is ruled out on 4% grade unless 35-mph is acceptable!

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Rail Technology Issues – Adhesion

EMU is superior for High-Gradient Applications

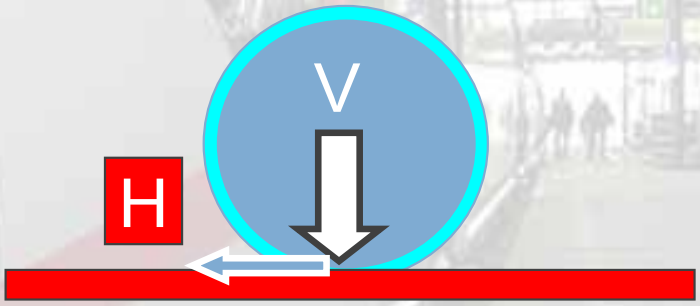
1st Generation ICE Train: Loco-Hauled

- Weight of two locomotives: 187 tons
- Total train 2,174,000 pounds for 645 seats
- Assume m = 15% *(A safe assumption for wet rails)*
- Tractive Effort Capability =
  187 x 2000 x 15% = 56,100 pounds
- **Maximum Grade = 56,100 / 2,174,000 = 2.6%**

3rd Generation ICE Train: EMU

- Train Weight: 1,000,000 pounds for 404 seats
- 50% of axles powered
- Assume m = 15%
- Tractive Effort Capability =
  500 x 2000 x 50% x 15% = 75,000 pounds
  (could be 150,000 pounds if all axles were powered)
- **Maximum Grade = 75,000 / 1,000,000 = 7.5%**
  (**<u>could make 15%</u>** if all axles were powered)

$$H = \mu V$$



μ = Coefficient of Adhesion

V = Vertical Component, Vehicle Weight

H = Horizontal Component, Tractive Effort

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Locomotive Hauled Vs Self Propelled

- **Locomotive-Hauled**

1st Generation ICE Train: Loco-Hauled

- The locomotive provides a buffer to the passenger compartment in case of a collision – In the US, passenger seating is prohibited in the leading unit of a Tier II passenger train.
- With modifications to add traction under first and last coaches as Eurostar does, could handle a 4% grade. (Eurostar routinely handles 3.5% grades in the Channel Tunnel.)

- **Self-Propelled**

3rd Generation ICE Train: EMU

- Every axle can be powered for more total power, but only 50% were needed in Germany.
- Greater operating efficiency and flexibility.
- FRA Regulations prohibit occupied 1st Car above 125-mph.
- Can handle a 7% grade if sufficient axles are powered.

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Maglev Technology Issues – Motor Type

- **LSM Motor (Guideway Based)**

German Transrapid

- Speeds of up to 300-mph proven in daily operation
- In operation at test track and Shanghai airport line
- Very expensive guideway
- It will be difficult to achieve the geometric standards required for a high speed guideway on the I-70 corridor. It may be achievable on a new I-25 greenfield alignment.
- General Atomics has LSM-based system on a test track for low-speed urban maglev application. (LSM is more efficient than LIM for large air gaps.)

- **LIM Motor (Vehicle Based)**

Japanese HSST

- This type of system was suggested by the 2004 Colorado Maglev study
- Speeds of up to 60-mph proven in daily operation – but speeds of 100-mph are unproven and require system enhancement
- LIM guideway reportedly more economical than LSM
- In operation at test track and Nagoya's Tobu Kyuryo line
- American Maglev has similar technology but no revenue implementation experience

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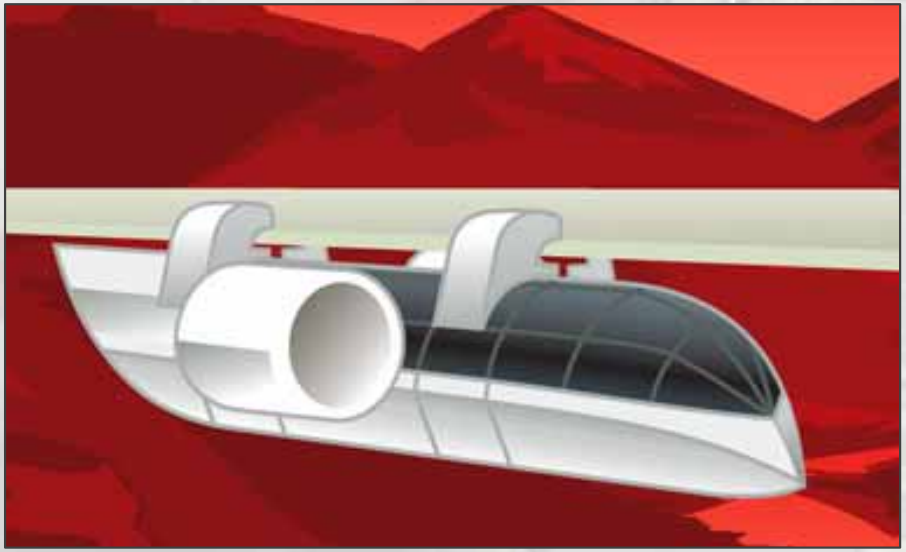
Novel Technologies

Sun Tram

Data Collection is Under Way . . . .

Air Train Global



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General Description Data

1. Vehicle Weight and Size
2. Parcel/Baggage Compartment Size
3. Seating Capacity and Configuration
4. Minimum Design Headways and Traffic Safety System
5. Ability to Move Between Cars
6. Ability to Provide Food Service
7. Emergency Evacuation Safety Procedures
8. Propulsion Power Characteristics
9. Station Design and Configuration

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Physical Characteristics Data

1. Maximum Gradient capability
2. Maximum Speed capability
3. Acceleration and Braking Curves as a function of gradient
4. Maximum Curve Superelevation
5. Power/Fuel consumption as a function of speed, gradient and load
6. Guideway Strength, Load Bearing and Geometric Alignment Requirements
   - Are these consistent with the design specifications and cost projections for the guide way?
7. Operational Reliability – In Service History

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Economic Characteristics Data

1. **Staffing**
   - Train Crew Size and Duties
   - Dispatch/Supervisory
   - Station Staffing and Roles
2. **Operating, Maintenance and Capital Cost History for:**
   - Vehicles
   - Switches and Guideways
   - Stations
   - Power Supply Systems
3. **Regulatory Approvals**

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Criteria for Selection of "Generic" Train

- **A non vendor-specific "generic" train profile will be developed.**
  - This profile represents the "typical" (not best) performance capabilities of equipment within each speed and performance category.
    - The "Generic Train" profile does not reflect a "best case" scenario; rather, it reflects broad performance parameters that a variety of technology vendors would be capable of meeting.
    - *As a rule, this leads to the specification of locomotive-hauled rather than EMU or DMU equipment options. One exception: EMU for I-70 High-Grade Option.*
  - This develops a conservative and achievable assessment of the operational and financial performance of the system.
- **By not tying the Operating and Financial analysis to any particular vendor's equipment, this approach:**
  - Streamlines the evaluation process.
  - Ensures transferability of the results.
  - Allows for a competitive equipment procurement.

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Representative Rail Equipment: Conventional Rail at 79-mph

Conventional Amtrak

Colorado Railcar DMU

Stadler FLIRT EMU

Key Characteristics

- Designed for operation at conventional speeds
- Can be diesel or electric
- Non-tilting

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Representative Rail Equipment: High Speed at 110-130 mph

Talgo T21

X 2000

Flexliner DMU

Key Characteristics

- Designed for operation above 100-mph on existing rail lines
- Can be diesel or electric
- Usually tilting unless line is very straight

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Representative Rail Equipment: Very High Speed at 150-220 mph

ICE-T EMU

TGV Atlantique

Amtrak Acela

Shinkansen

Key Characteristics

- High-Powered - for operation at 150-mph or higher on new lines.
- Electric only.
- Tilt train versions have been developed to allow trains to go around curves faster. Only tilting equipment will be considered for Colorado.

Eurostar

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Representative Maglev Equipment: High Speed at 110-130 mph

Proposed Colorado Maglev

American Maglev

HSST

Key Characteristics

- High-Speed derivatives of Urban Maglev designs.
- Some urban maglev systems are operational, but the modifications needed to prove high speed capability are still in the R&D phase.
- For evaluation purposes however, we are treating these systems as if they were operational today.

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Representative Maglev Equipment: Ultra High Speed at 250-300 mph

Transrapid Maglev

Key Characteristics

- High-Speed Maglev.
- Only one operational system (Transrapid) in this class today although there are additional concepts in R&D throughout the world.
- For evaluation purposes the Transrapid system will be assumed.

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Thank You

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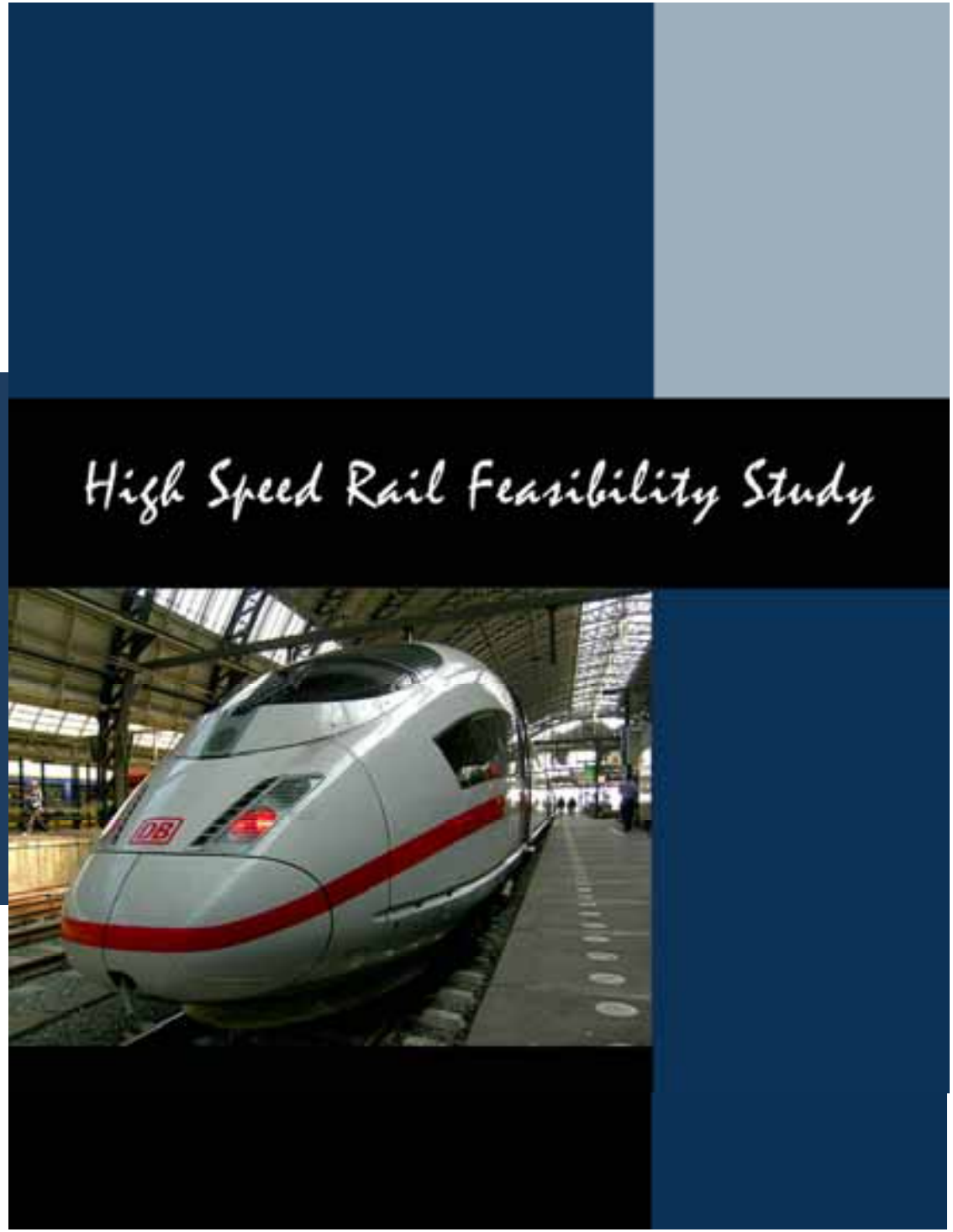
APPENDIX E: OPERATING COST PRESENTATION

Presentation To

RMRA Peer Panel Workshop – Day #1

Operating Costs

November 19, 2008



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Presentation Outline

- **Operating costs background**
  - Definitions
  - Economies of scale
  - Benchmarking comparisons
- **Detailed cost items review**
  - Variable cost items
  - Fixed cost items
- **Summary**
  - Interactive analysis
  - Integration with financial planning process
  - Conclusions

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FRA Definition of "Operating Cost"

Revenue

FRA Evaluation Framework for Commercial Feasibility

Variable Operating Cost

First Financial Threshold

1. Covers Variable and makes a Contribution to Fixed Cost

Fixed Operating Cost

Second Financial Threshold

2. Free Cash Flow, or "Operating Surplus"

Capital Cost
(Includes Interest + Depreciation)

"Positive Franchise Value" should lead to a Partial Return of Capital to State/Local Entities

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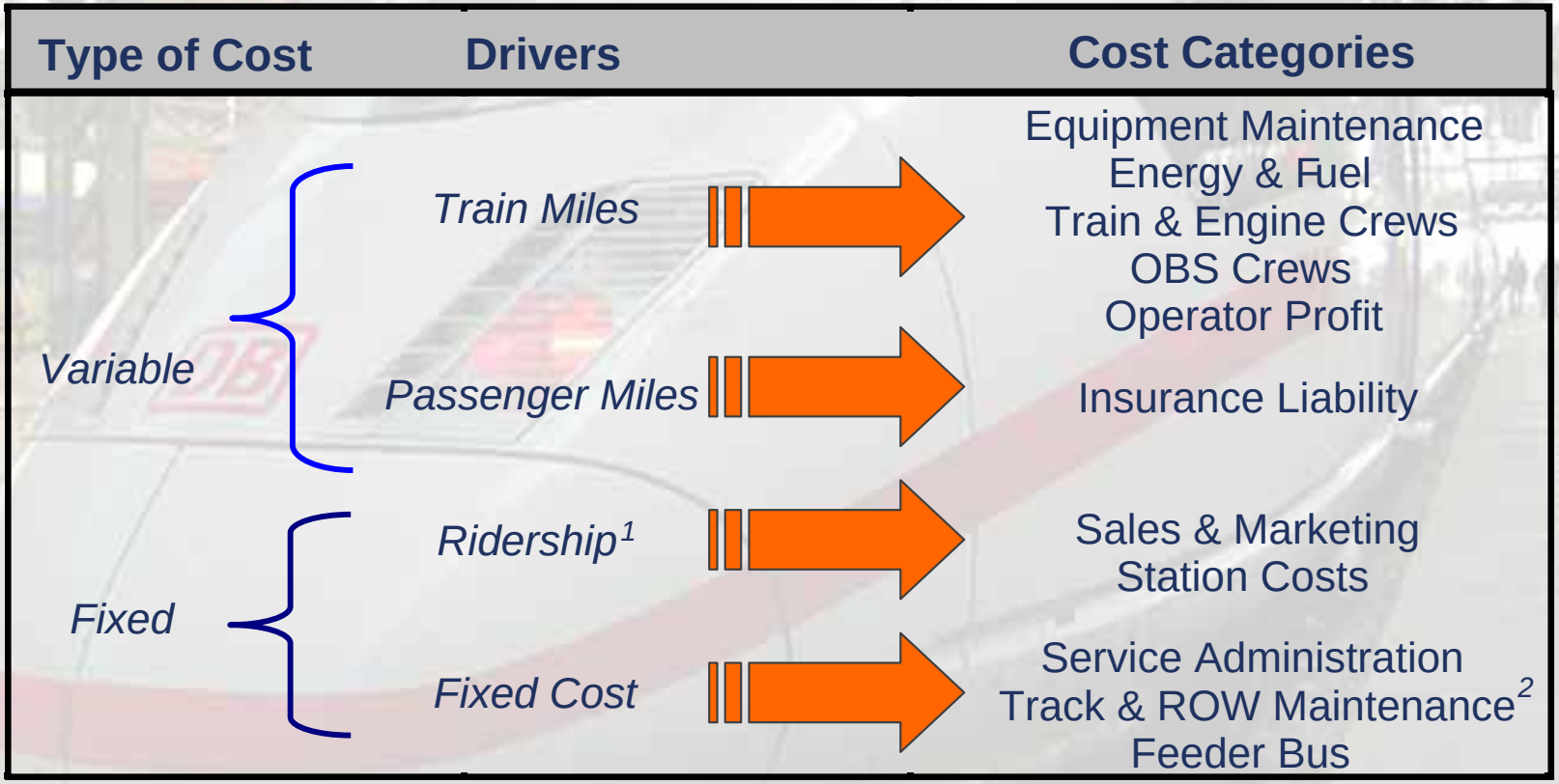
Operating Cost Categories

"Bottom-Up" Framework resulted from previous multi-year, multi-state planning efforts (e.g., MWRRI and Florida Business Plans)



[1] Station costs as well as sales and marketing are only affected weakly by ridership, so these two costs can be considered fixed for practical purposes.

[2] For improved track, maintenance costs are affected more by freight tonnage than by passenger train-miles.

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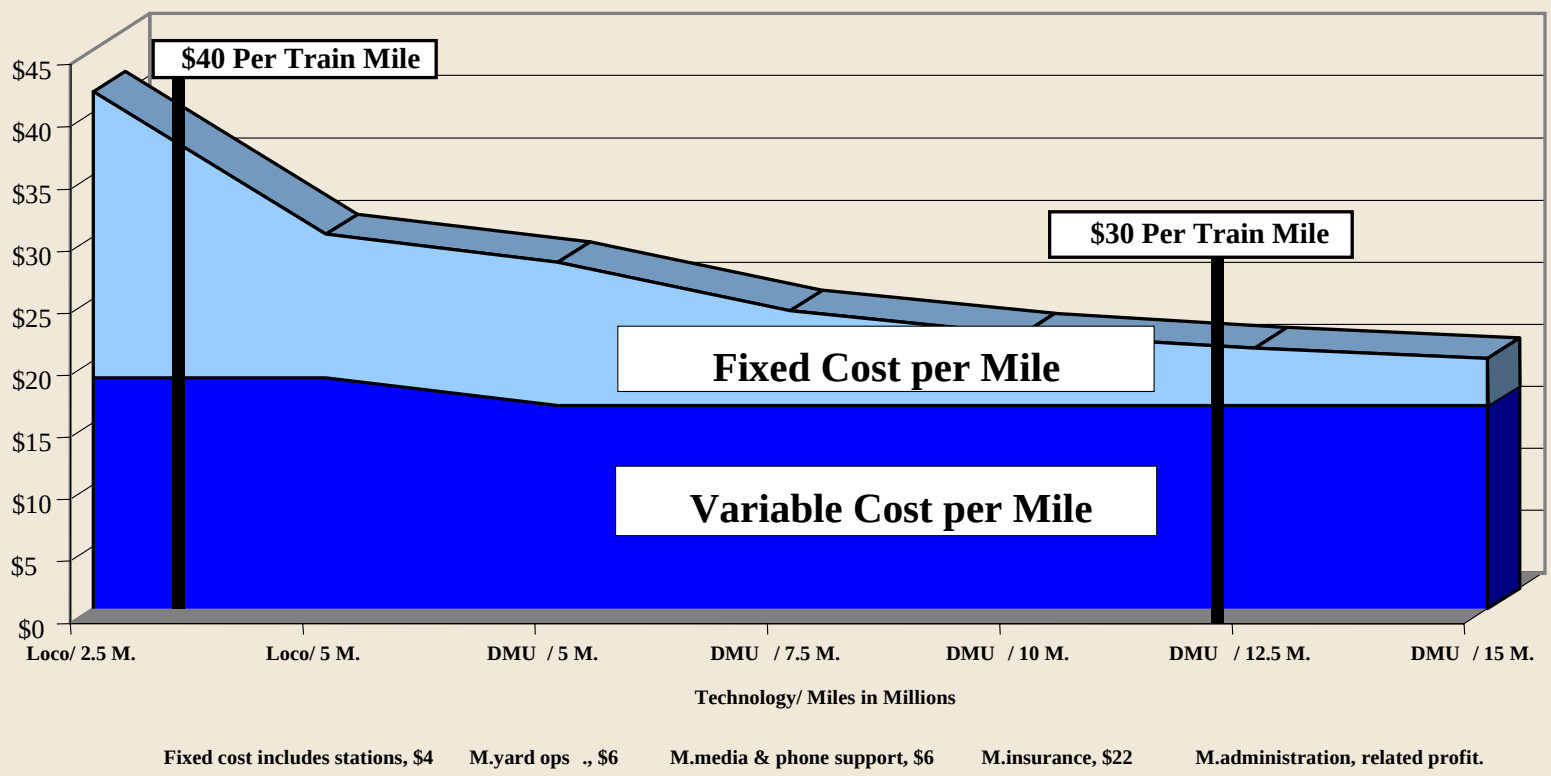
“Railroading is a Volume Business”
(Strong Economies of Scale Relationship)



This could be an issue for either I-25 or I-70 systems by themselves, but are unlikely to be a problem for the two systems combined.

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Benchmark – Amtrak Fully Allocated Costs

$2002 Costs have increased by 10-20% which would put typical costs in the $35-45 range now

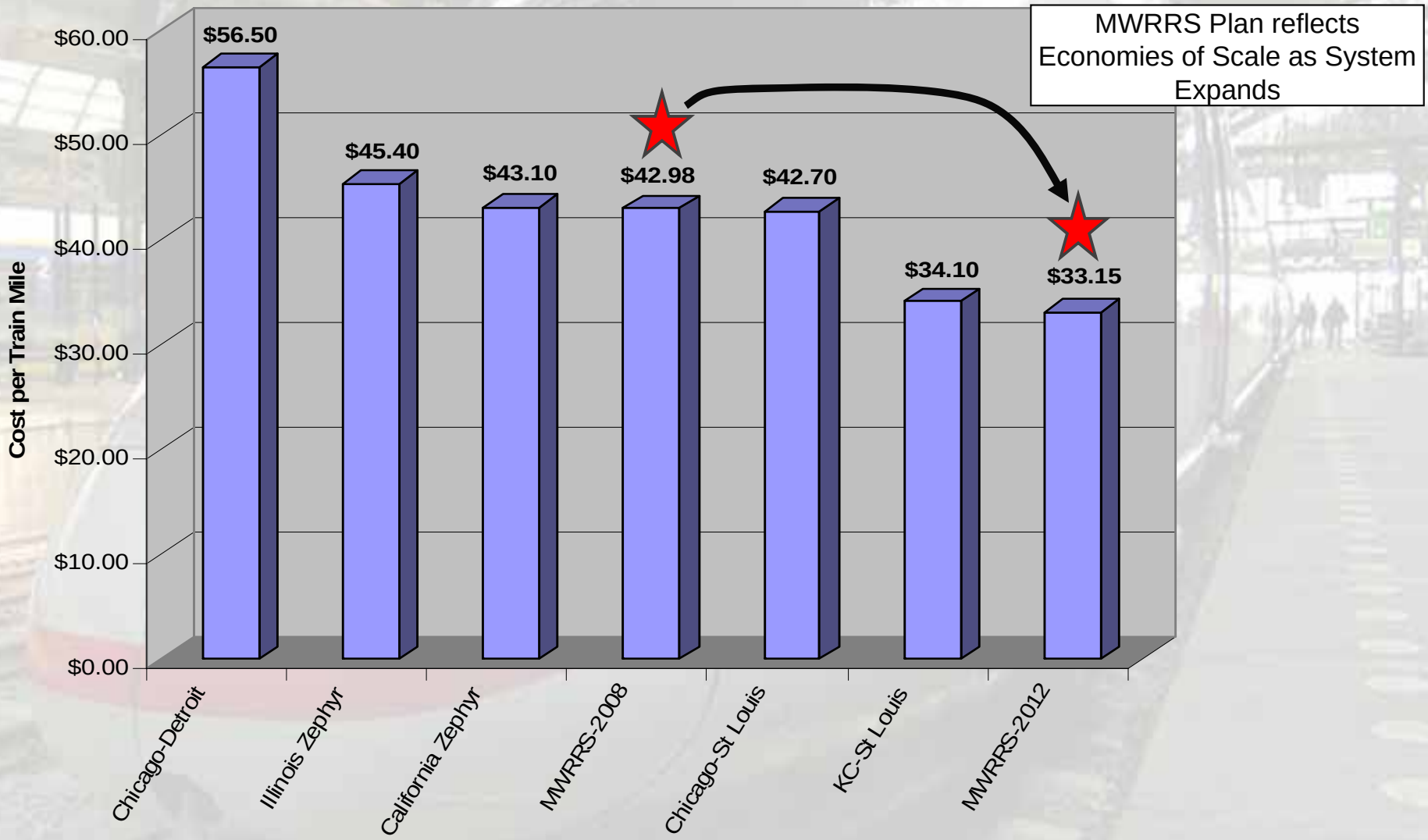

Exhibit 10-22 from MWRRS Report: 1997 Amtrak costs adjusted for inflation to 2002, ***excluding interest and depreciation.***
Source*: Intercity Passenger Rail: Financial Performance of Amtrak's routes*, U.S. General Accounting Office, May 1998.

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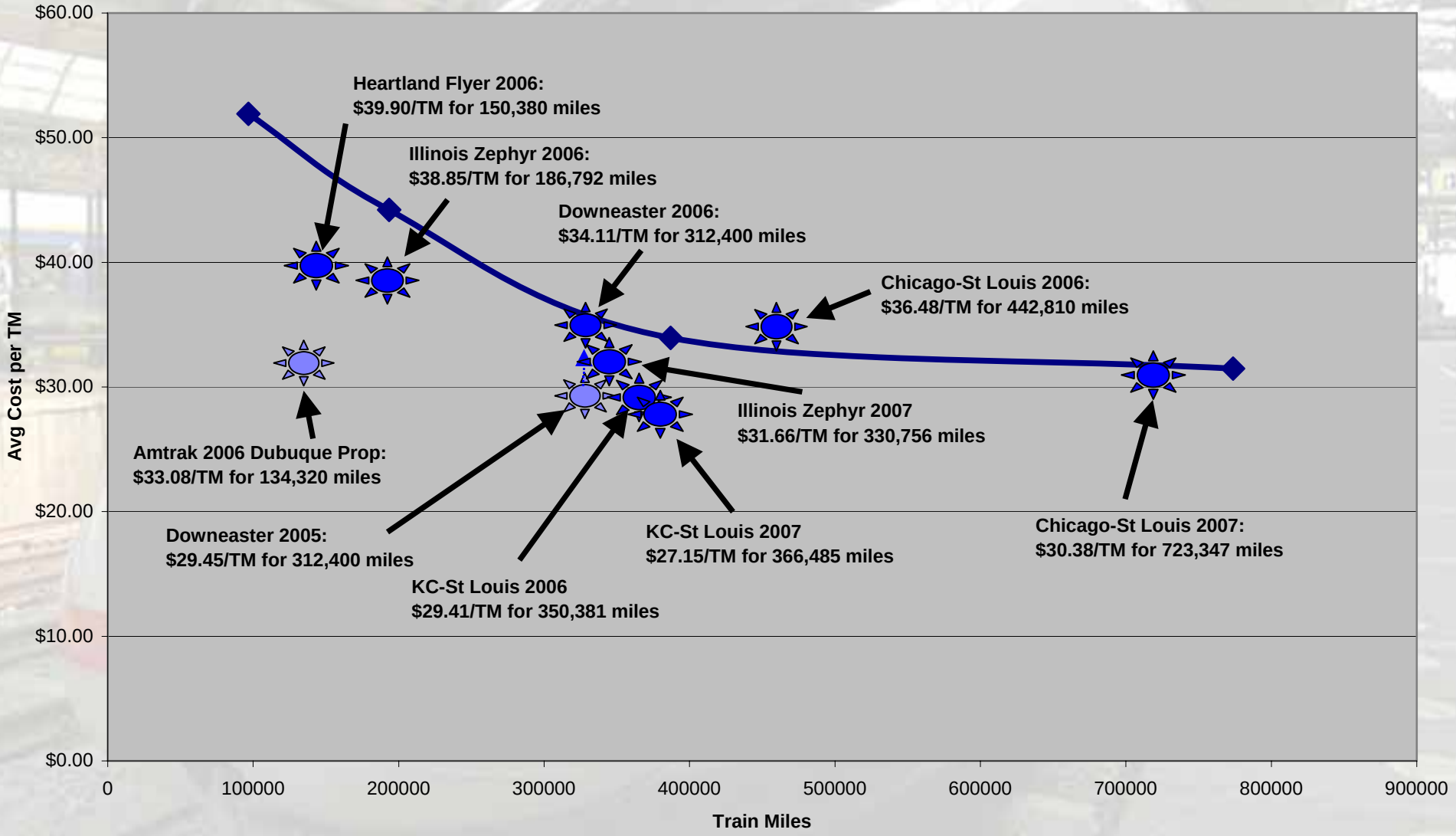
Benchmark Costing Comparison

(Typical costs in $30-40 range per Train Mile, w/Scale Economies)



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Variable Cost Items – Equipment

- **Equipment Costs were developed in conjunction with Amtrak and Equipment Manufacturers and assumed:**
  - Typical American maintenance practices (European costs would be 20-30% lower)
  - Large system economies-of-scale (Small system could cost 25% more)
- **Example Diesel T21 MWRRI Costs (in $2002)**
  - $9.87 per Train Mile 300-seat train
  - $8.95 per Train Mile 200-seat train
  - DMU equipment costs were estimated about the same for a 300-seat train, but would scale more linearly to smaller or larger train sizes
  - Electric and Maglev Equipment costs under review

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Variable Cost Items – Energy and Fuel

- **Fuel consumption rate**
  - 2.42 gallons/train-mile were estimated for a 110-mph 300-seat T21. Cost scales proportional to train weight:
    - Locomotive hauled has a minor impact for a larger or smaller train due to fixed weight of locomotives.
    - DMU/EMU has a linear relationship to train size.
    - Electric power for steel wheel and maglev, will consider regeneration both in braking and going down hill.
- **Fuel and Electric price scenarios**
  - These can be developed for a reasonable range of prices but we proposed an equilibrium gasoline price of $2.75 per gallon.
  - Whatever diesel fuel price is assumed on the cost side, it must be consistent with the gas price assumed for the ridership projection.
  - Electric costs must add in cost of transmission/catenary system.

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Variable Cost Items –Train Crews

- **Amtrak staffing rules for conservatism in rail costs**
  - Baseline train crews consist of an engineer, conductor and assistant conductor subject to hours-of-service regulations
  - Smaller crews can be considered for DMU, EMU and maglev vehicles based on specific operating requirements
- **Staffing practices and costs**
  - Crew costs depend upon the level of utilization, largely influenced by the structure of crew bases, length of routes, and level of train frequencies. Example average costs ($2002):
    - $3.42 per train mile for efficient round trips with no need for overnight accommodations.
    - $3.94 per train mile if some overnight layovers are required.
    - $6.60 per train mile because of extremely poor utilization in some low frequency start-up scenarios.
  - Exact costs cannot be estimated until schedules have been developed.

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Variable Cost Items – OBS Crews

- **OBS crews**
  - $1.67 per train mile ($2002) for labor and commissary support.
  - Cost of goods sold = 50% of OBS revenue.
- **Key to OBS profitability is selling enough product to recover labor cost**
  - Trolley cart service boosts revenue by 50-100% due to added customer convenience.
  - Cost of dedicated bistro can only be supported by large trains (> 300 seats).
  - Trolley cart comes close to a “break even” proposition or a slight profit, because its main value is to enhance the customer’s rail travel experience.

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Variable Cost Items – Insurance Liability

- **Insurance liability**
  - 1.2¢ per passenger-mile for MWRRS ($2002).
  - FELA (employee injury) costs not included here but are included as part of the labor rate in the respective categories.
  - Strong economies of scale/institutional issues with respect to ability to obtain insurance at a reasonable cost.
  - Amtrak reform and accountability act of 1997 (§161) limits passenger liability claims of $200 million per event, which enables passenger operators to satisfy freight railroad requirements for full indemnification.

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Fixed Cost Items – Administration, Sales and Marketing

Management, Administrative and Call Center Costs were further refined by splitting them into Fixed and Variable Cost Components.

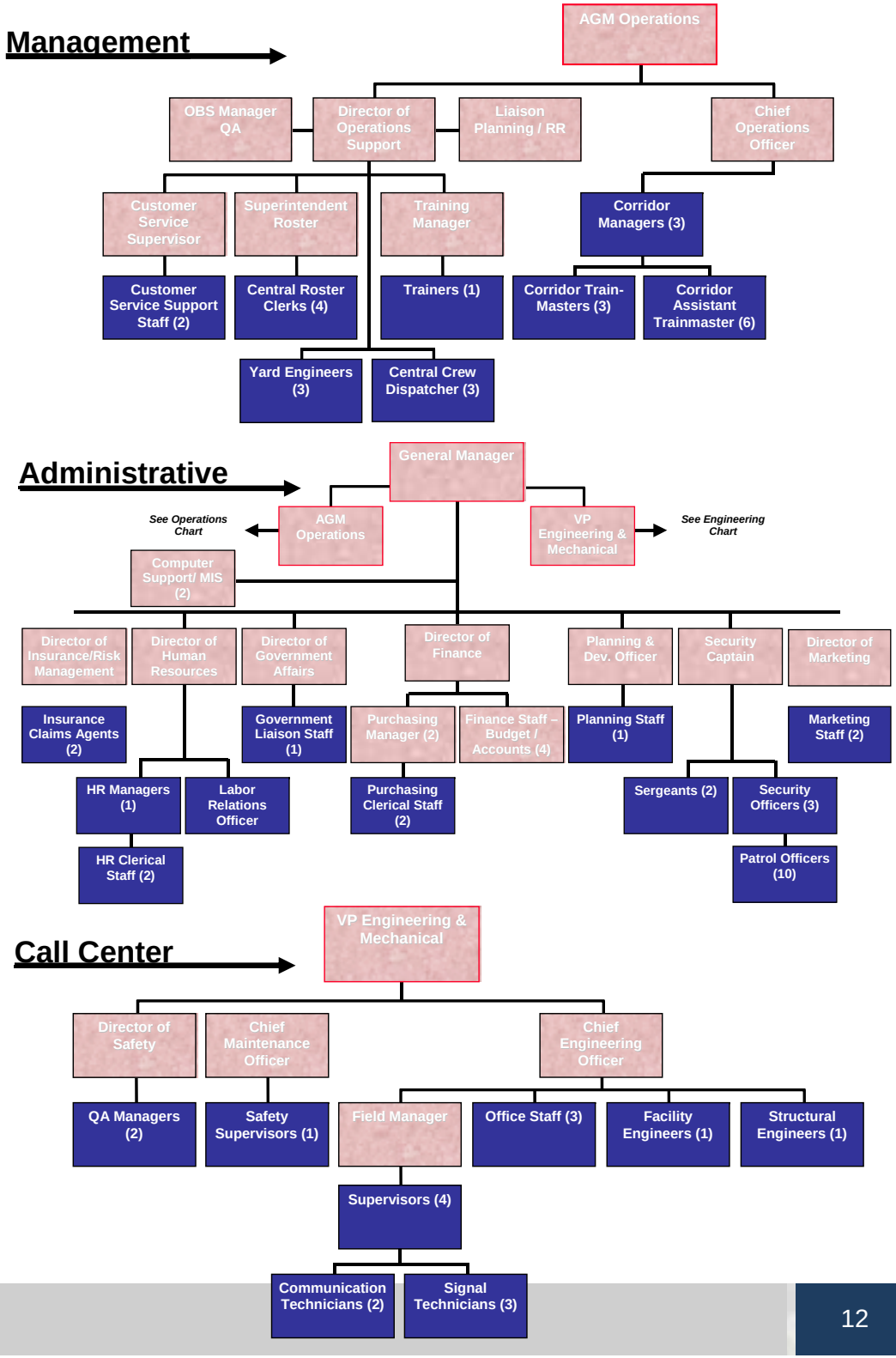
Pink- Fixed ***Blue- Variable by Train Miles***

RESULTING FIXED COST ($2006):

Call Center: $2.5 Million
Management + Admin: $9.7 Million

Variable Components:

$1.56 per Train-Mile Admin, 62¢ per Rider Call Center, 1.8% Revenue for Credit Card Commissions, 1% Revenue Sales Commissions



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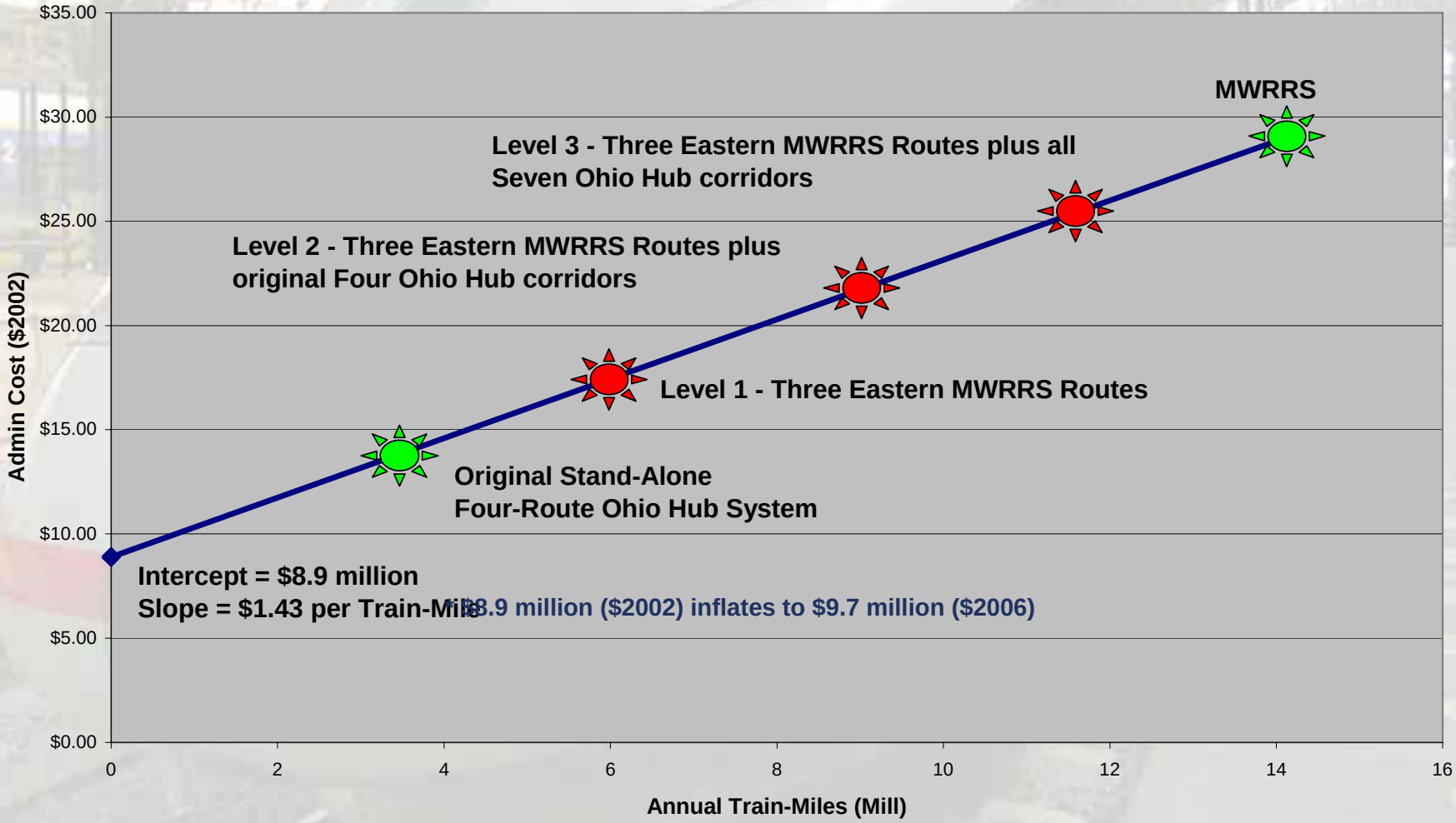
Fixed Cost Items – Administration, Sales and Marketing

Stand alone administrative cost structure ($2002*)



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Variable Cost Items – Operator Profit

- **Operator profit**
  - For planning purposes, the MWRRS allowed a gross operator profit based upon 10 percent of directly-controlled costs, including:
    - Insurance, station, sales and marketing, service administration, train crew, and energy and fuel.
  - All other costs, such as train equipment maintenance, are assumed to be out-sourced. These costs for externally contracted services are excluded from the operator's profit margin, and are assumed to each include their own 10 percent profit margin.
  - Gross operator profit is allocated to the operator as a performance incentive.
  - For small systems the operator profit is assumed to be embedded in the $5 per train mile allowance that was derived from the corridor benchmarking analysis.

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Fixed Cost Items – Station Costs

- **Station costs**
  - Rail system provides basic rail facilities such as platform and tracks, community provides the rest of the station.
  - Station costs assume a simplified fare structure, heavy reliance upon electronic ticketing and avoidance of a reservation system will minimize station personnel requirements. Station costs include personnel, ticket machines and station operating expense. Costs (in $2002):
    - Unstaffed station $45,872 per year.
    - Staffed station $538,332 per year.

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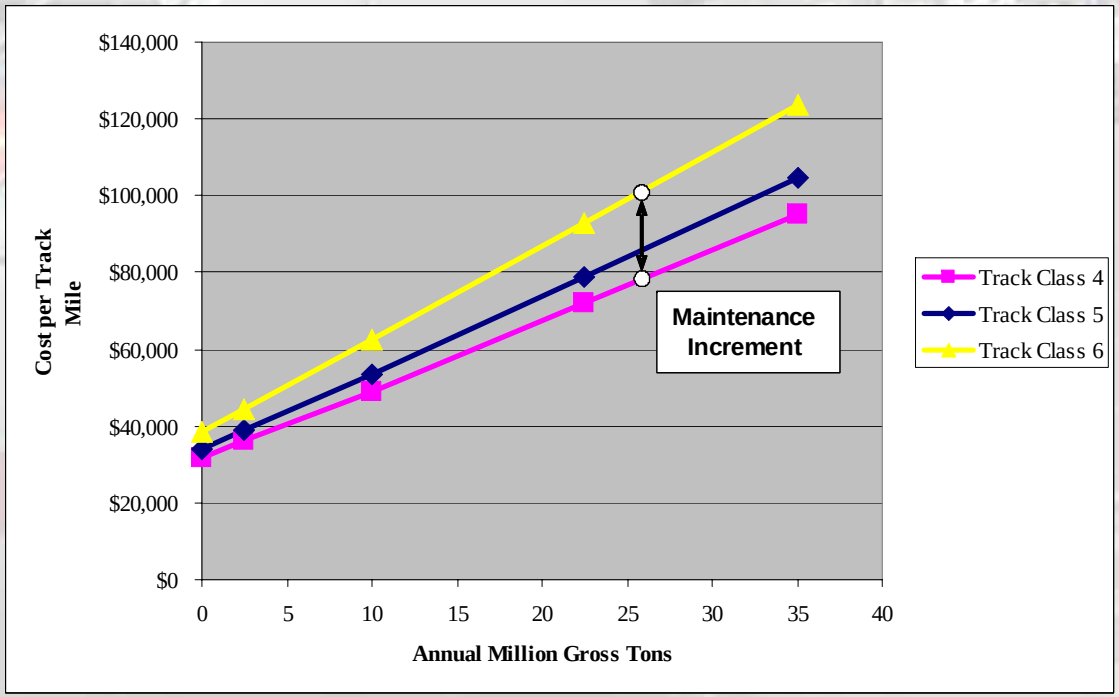
Fixed Cost Items – Track Maintenance

- **Track and ROW Maintenance**
  - Follows Zeta-Tech methodology, depends heavily on Track Class and Gross Tonnage.
    - However, on shared tracks, most Tonnage is usually contributed by freight.
    - Includes additives for dispatching, out-of-pocket reimbursement, and on shared tracks, a contribution towards freight railroads' fixed cost.
    - For dedicated tracks the passenger service pays the fixed cost, but freight usage fee may recover part of the cost.



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Fixed Cost Items – Feeder Bus

- **Feeder bus**
  - For MWRRS study, bus costs were estimated as $1.72 or $2.15 per mile (in $2002) for small or large buses, respectively.
    - This figure was supplied by Greyhound.
  - Structure of feeder bus network will depend on the rail stations chosen.
  - Cost may not be relevant to rail business plans, if we assume that the feeder buses are provided by local transit operators (e.G. RTD, RFTA, etc.)

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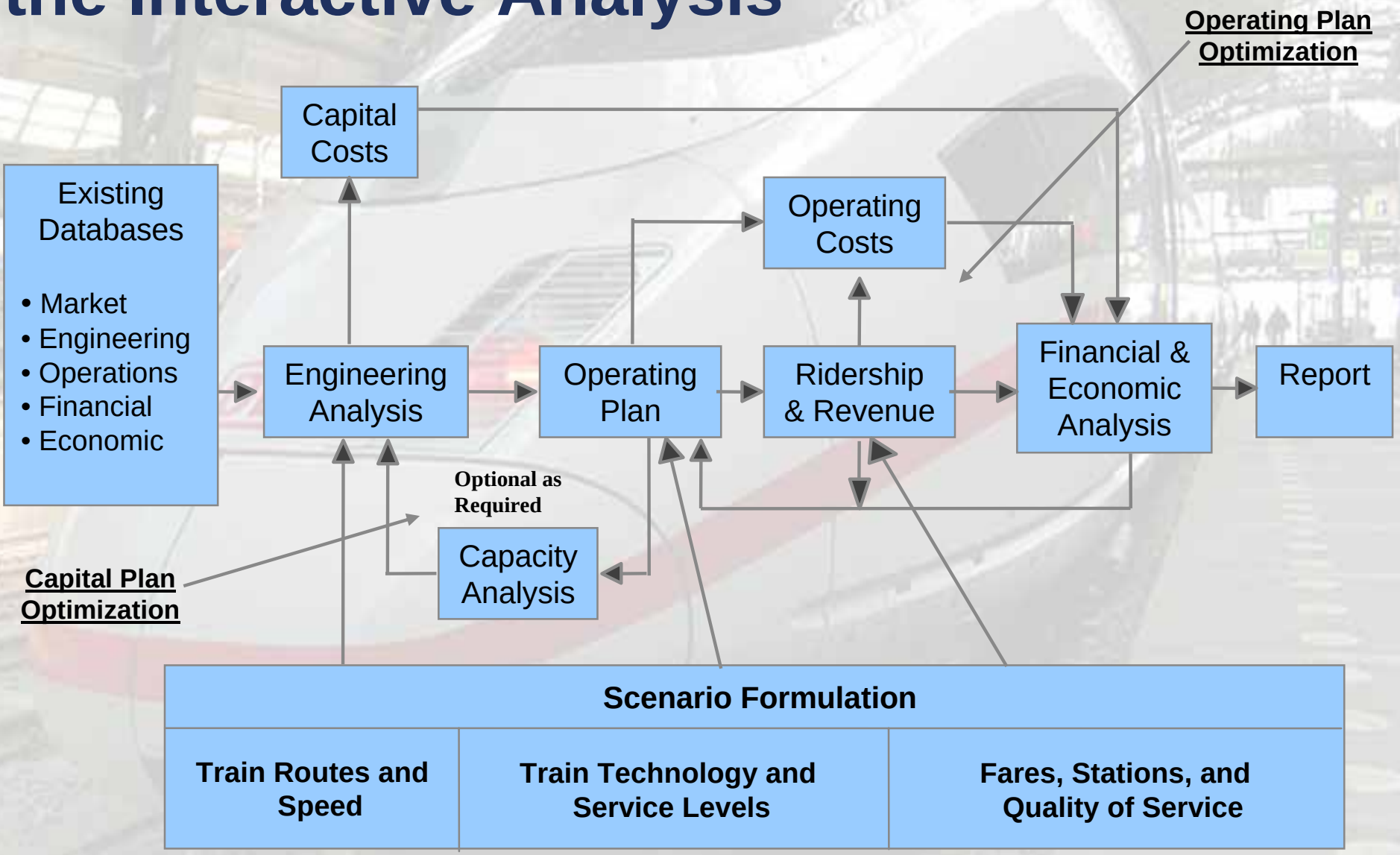
Operating Costs are a Key Component of the Interactive Analysis



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Operating Costs Are Key to Commercial Feasibility

- **They enter into both:**
  - Operating Ratio
  - Cost Benefit Ratio
- **In the MWRRS example, the operating profit positive NPV contributes to improving the Cost Benefit ratio.**

Benefits	Billions in 1998 dollars
MWRRS User Benefits	
Consumer Surplus (e.g., time savings expressed as dollars)	$6.4
System Revenues	$6.8
Other Mode User Benefits	
Airport Congestion Relief	0.7
Highway Congestion Relief	1.3
Resource Benefits	
Air Carrier Operating Cost Reductions	0.4
Emission Reductions	0.3
Total Benefits	$15.9
Costs	
Capital	$4.1
Financing	0.2
Operating and Maintenance	5.0
Total Costs	$9.3
Ratio of Benefits to Costs	1.7

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Conclusions

- **The Costing Framework has been developed over the course of many previous studies, and has been extensively used and validated.**
  - To be brought up to a current costing basis using appropriate inflation adjustments.
  - Additional categories of cost, e.g. electric power consumption and catenary maintenance, to be developed and added to the framework.
- **Operating Cost results are a key determinant of the commercial feasibility of the system.**
  - They directly determine the operating ratio and strongly influence the Cost Benefit ratio.
  - Interactive optimization process seeks to match supply to demand for obtaining the best possible fit to market requirements and financing capabilities.

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APPENDIX F: CORRIDOR DEVELOPMENT PRESENTATION

Map #1
I-25 North of Denver

TEMS/Quandel Consultants, LLC

N

4 2 0 4 Miles

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Cheyenne

Legend

Stations

- Main Station
- Secondary Station
- UPRR - Denver Terminal
- Greenfield Alignment
- Existing Rail Alignment
- High Speed Rail Alignment
- Existing Railroad
- I-70
- I-25/Greenfield
- Highways
- COUNTIES

Map prepared: November 13, 2008
Data source: Colorado DOT

LARIMER COUNTY

Fort Collins

WELD COUNTY

Greeley

Loveland

025A

Longmont

BOULDER COUNTY

Boulder

North Suburban

BROOMFIELD COUNTY

ADAMS COUNTY

DIA - HSR Accessway & Terminal (TBD)

Denver International Airport

Denver International Airport

GILPIN COUNTY

Central City

Black Hawk

Idaho Springs

JEFFERSON COUNTY

Golden

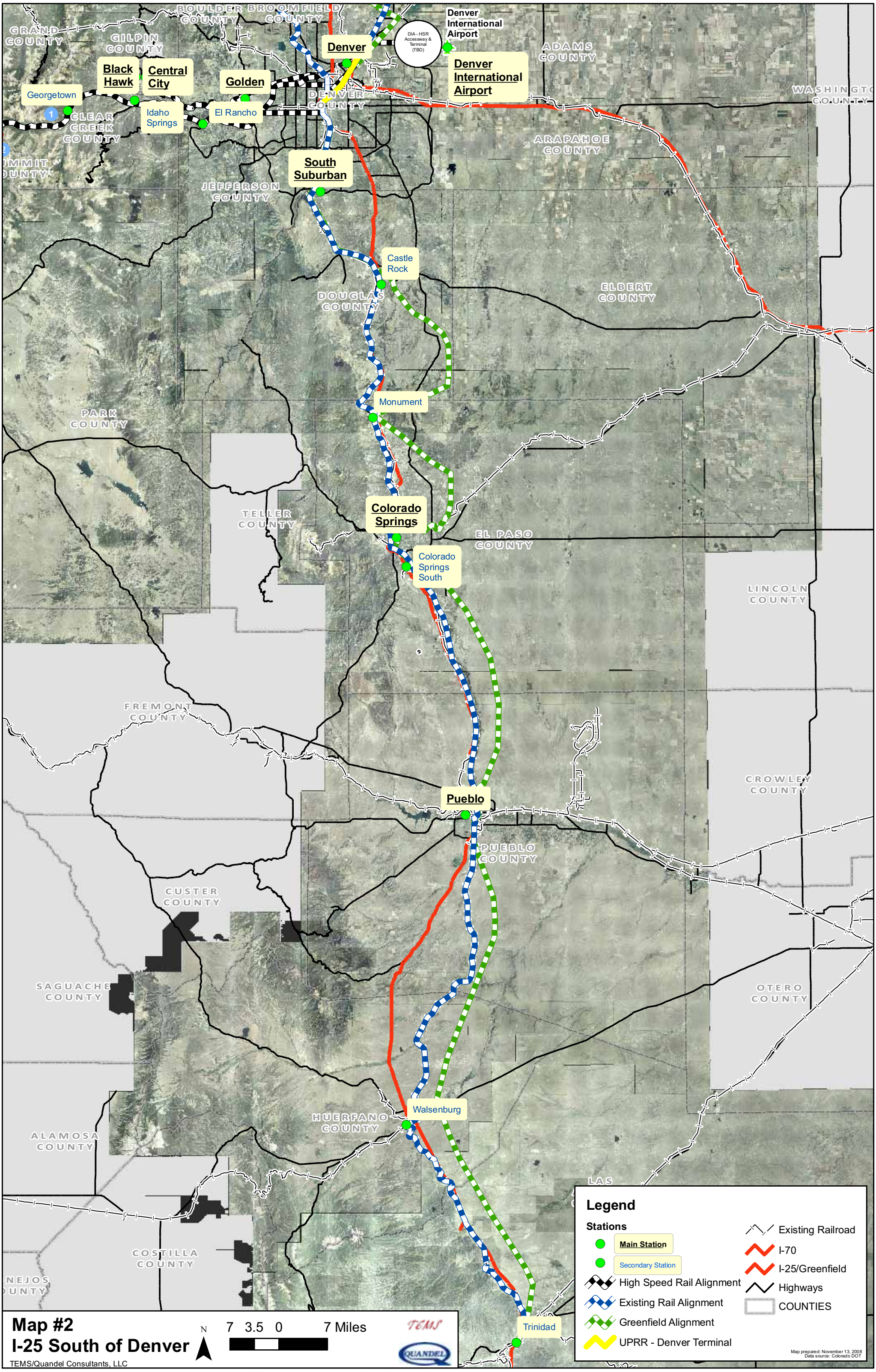
Denver

DENVER COUNTY

CLEAR CREEK COUNTY

DOUGLAS COUNTY

ARAPAHOE COUNTY


Denver International Airport
DIA - HSR Accessway & Terminal (TBD)
Denver
Denver International Airport
Black Hawk
Central City
Golden
Georgetown
Idaho Springs
El Rancho
South Suburban
Castle Rock
Monument
Colorado Springs
Colorado Springs South
Pueblo
Walsenburg
Trinidad
GRAND COUNTY
BOULDER COUNTY
BROOMFIELD COUNTY
GILPIN COUNTY
CLEAR CREEK COUNTY
DENVER COUNTY
ADAMS COUNTY
ARAPAHOE COUNTY
JEFFERSON COUNTY
DOUGLAS COUNTY
ELBERT COUNTY
PARK COUNTY
TELLER COUNTY
EL PASO COUNTY
LINCOLN COUNTY
FREMONT COUNTY
CROWLEY COUNTY
PUEBLO COUNTY
CUSTER COUNTY
SAGUACHE COUNTY
OTERO COUNTY
HUERFANO COUNTY
ALAMOSA COUNTY
COSTILLA COUNTY
Legend
Stations
Main Station
Secondary Station
High Speed Rail Alignment
Existing Rail Alignment
Greenfield Alignment
UPRR - Denver Terminal
Existing Railroad
I-70
I-25/Greenfield
Highways
COUNTIES
Map prepared: November 13, 2008
Data source: Colorado DOT
Map #2
I-25 South of Denver
N
7 3.5 0 7 Miles
TEMS
QUANDEL
TEMS/Quandel Consultants, LLC

I-70 Tunnel Options

1.) Georgetown
2.) North Fork
3.) Breckenridge
4.) Aspen
5.) Black Hawk

* the need for additional tunnels will be evaluated in the alternative development phase

Longmont
Boulder
North Suburban
Denver
Denver International Airport
DIA - HSR Accessway & Terminal (TBD)
Golden
Central City
Black Hawk
Idaho Springs
El Rancho
Georgetown
Vail
Dillon
Keystone
Frisco
Red Cliff
Copper Mountain
Breckenridge
Climax
South Suburban

Black Hawk Tunnel
LT 6,000 ft.

North Fork Tunnel
LT 25,000 ft.

Georgetown Tunnel
LT 14,000 ft.

Breckenridge Tunnel
LT 22,000 ft.

GRAND COUNTY
BOULDER COUNTY
WELD COUNTY
BROOMFIELD COUNTY
ADAMS COUNTY
GILPIN COUNTY
DENVER COUNTY
CLEAR CREEK COUNTY
ARAPAHOE COUNTY
JEFFERSON COUNTY
EAGLE COUNTY
SUMMIT COUNTY
PARK COUNTY
PITKIN COUNTY

Map #3
I-70 East of Avon
TEMS/Quandel Consultants, LLC

N
4 2 0 4 Miles

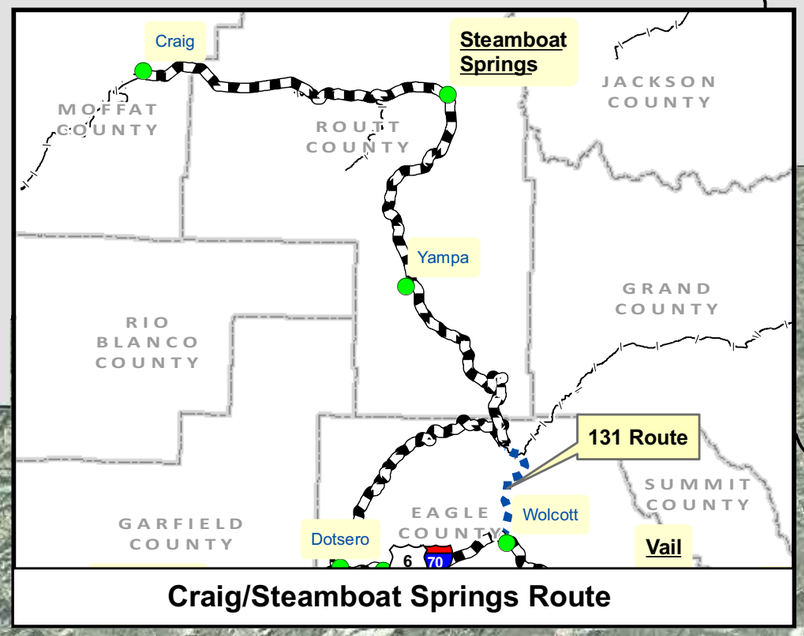
TEMS
QUANDEL

Legend

Stations
- Main Station
- Secondary Station

High Speed Rail Alignment
Off I-70 Corridor Route
Tunnel
Existing Railroad
Highways
I-70
COUNTIES

Map prepared: November 13, 2008
Data source: Colorado DOT



Craig/Steamboat Springs Route

I-70 Tunnel Options

1.) Georgetown
2.) North Fork
3.) Breckenridge
4.) Aspen
5.) Black Hawk

* the need for additional tunnels will be evaluated in the alternative development phase

ROUTT COUNTY
GRAND COUNTY
SUMMIT COUNTY
Wolcott
Dotsero
Gypsum
Eagle
EAGLE COUNTY
Avon
GARFIELD COUNTY
Glenwood Springs
Rifle
Parachute
Aspen Tunnel
L_T 51,000 ft
4
Basalt
Aspen
PITKIN COUNTY
MESA COUNTY
Grand Junction
DELTA COUNTY
GUNNISON COUNTY

Legend

Stations
- Main Station
- Secondary Station

High Speed Rail Alignment
Off I-70 Corridor Route
Tunnel
Existing Railroad
Highways
I-70
COUNTIES

Map prepared: November 13, 2008
Data source: Colorado DOT

Map #4
I-70 West of Avon

N
5 2.5 0 5 Miles

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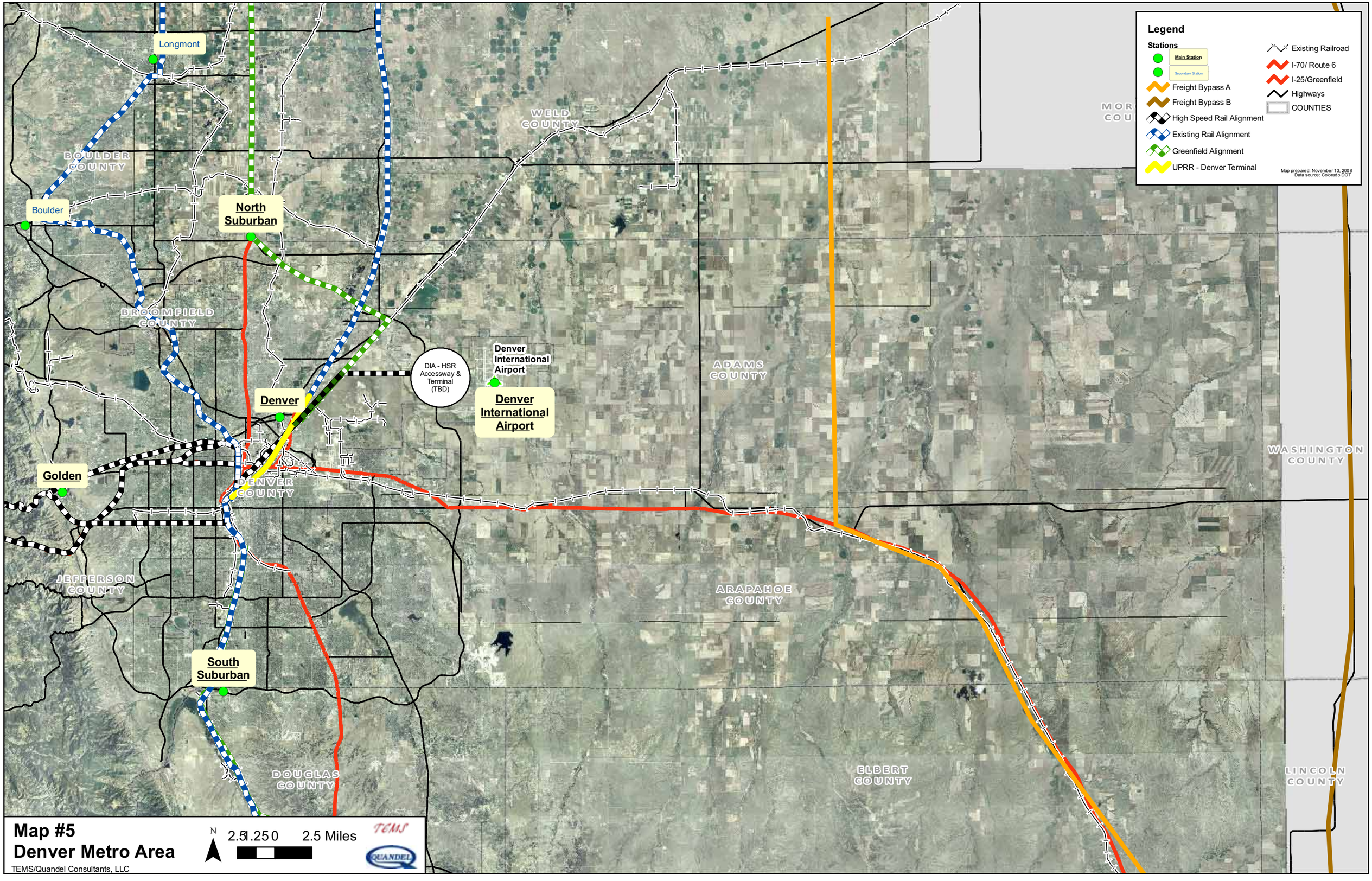
Longmont
Boulder
North Suburban
Denver
Denver International Airport
DIA - HSR Accessway & Terminal (TBD)
Golden
South Suburban
BOULDER COUNTY
BROOMFIELD COUNTY
WELD COUNTY
ADAMS COUNTY
DENVER COUNTY
JEFFERSON COUNTY
ARAPAHOE COUNTY
DOUGLAS COUNTY
ELBERT COUNTY
WASHINGTON COUNTY
LINCOLN COUNTY
Legend
Stations
Main Station
Secondary Station
Freight Bypass A
Freight Bypass B
High Speed Rail Alignment
Existing Rail Alignment
Greenfield Alignment
UPRR - Denver Terminal
Existing Railroad
I-70/ Route 6
I-25/Greenfield
Highways
COUNTIES
Map prepared: November 13, 2008
Data source: Colorado DOT
Map #5
Denver Metro Area
N
2.5 1.25 0 2.5 Miles
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APPENDIX G: CAPITAL COST SPREADSHEETS